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WATER QUALITY STUDY IRRIGATION BLOCKS 74 & 741

Quincy, Washington

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WATER QUALITY STUDY
IRRIGATION BLOCKS
74 & 741
Quincy, Washington

By

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This study was conducted as a cooperative effort by the U. S. Soil Conservation Service, Quincy Conservation District, Quincy-Columbia Basin Irrigation District, Washington State Department of Ecology, U. S. Bureau of Reclamation, and the Grant County Cooperative Extension Service.

660767

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ACKNOWLEDGEMENTS

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INTRODUCTION

Quality of irrigation water is a continuing problem of major significance in irrigated areas of the United States. Irrigation farmers, conservationists, and those responsible for delivery of irrigation water in the Columbia Basin Irrigation Project are deeply concerned about the problem. Downstream water users especially have been increasingly concerned during recent years about the quality of water in return flows. The need for data on water use and water quality has become apparent.

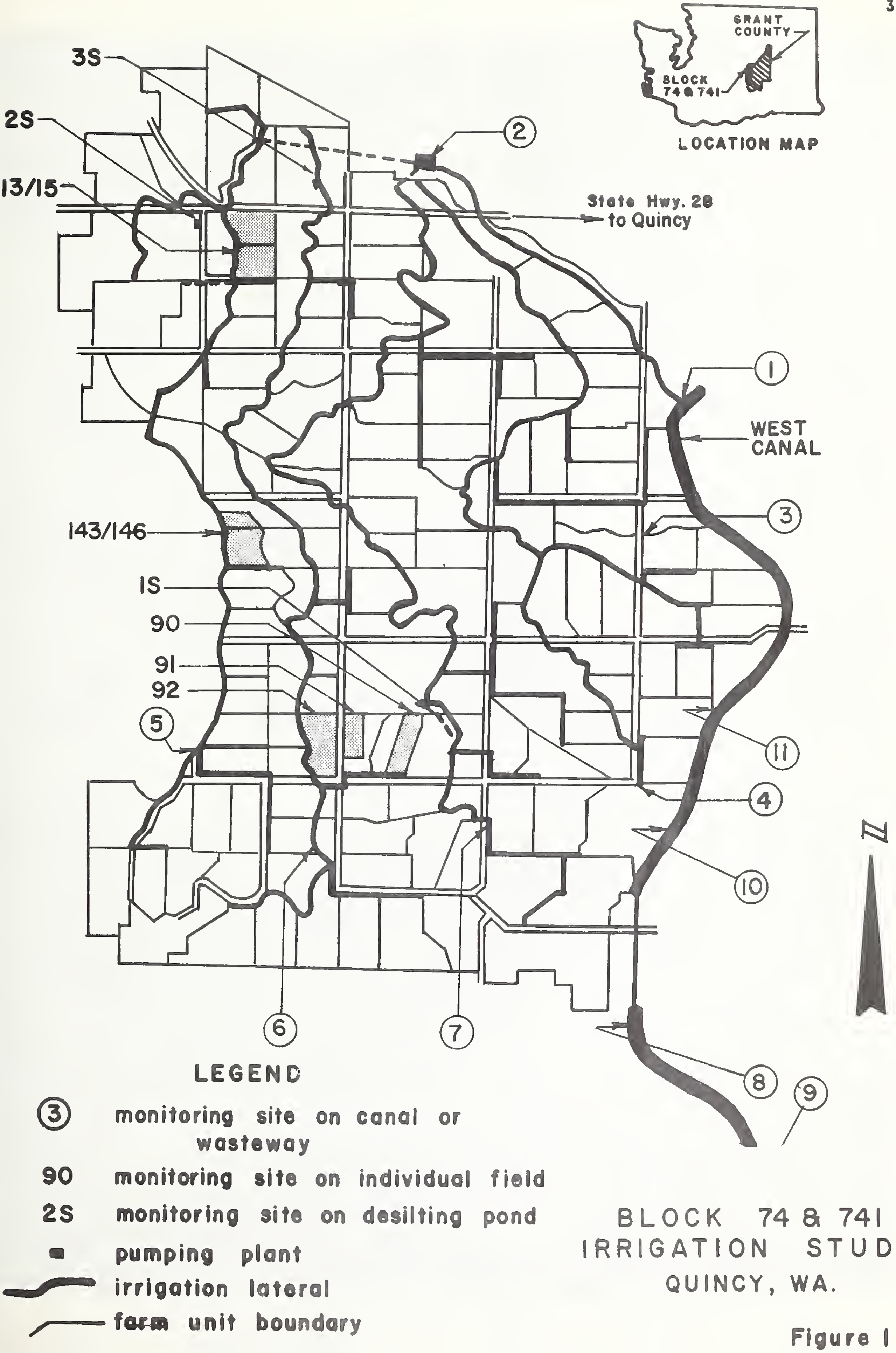
In irrigation blocks 74 and 741 of the Quincy-Columbia Basin Irrigation District, where the problem is particularly severe, farmers formed a special task force to obtain more data on water use and water quality deterioration. The task force requested assistance from the Quincy Conservation District which, in turn, asked for help from the Soil Conservation Service.

On April 3, 1974, Soil Conservation Service personnel met with representatives of the U. S. Bureau of Reclamation, Washington State Department of Ecology, Quincy-Columbia Basin Irrigation District, and the Cooperative Extension Service and agreed to join in a cooperative effort to secure the needed data.

A study program was devised to run from the beginning to the end of the 1974 irrigation season. In the study, coordinated by the Soil Conservation Service, sampling stations were established on 7 points on canals, 4 points on wasteways, 5 irrigated fields, and 3 desilting ponds. Forty-three water samples were taken per week. Water quantity and quality (turbidity and suspended solids) were measured as delivered to the irrigation blocks and to the study farms. Tailwater leaving the study farms as well

as water leaving the entire stury area was monitored. No attempt was made to alter timing, extent or types of management practiced by the operator on any of the stury sites. Results of management practices were noted where evidence was still apparent at the time of sampling. Effects of three desilting ponds in the improvement of water quality also were studied.

Under the cooperative agreement among participating agencies, the Washington State Department of Ecology participated through partial funding of the study. Quincy-Columbia Basin Irrigation District provided funding and field staff assistance in measuring and reporting water delivery data. Quincy Conservation District assisted in coordination of the study and enlisting cooperation of farmers in the study. The U. S. Bureau of Reclamation provided training in water quality sampling and testing procedures and has provided field use of their soils laboratory for the study. The Cooperative Extension Service assisted in development of the study procedure and analysis of data collected. The Soil Conservation Service provided overall supervision in execution and completion of the study. SCS compiled, edited and published the results of the study which are set forth in this report.



BLOCK 74 & 741
IRRIGATION STUDY
QUINCY, WA.

Figure 1


3778

STUDY AREA DESCRIPTION

Irrigation blocks 74 and 741 are four miles west of Quincy Washington in the Columbia Basin Irrigation Project. Combined acreage of the blocks is 13,200 acres, which is divided into 162 farm units. The average annual rainfall is 8 to 12 inches occurring mostly in the winter months. Elevations range from 1300 to 1600 feet above sea level. Major crops grown during the 175-195 day growing season are potatoes, sugar beets, wheat, corn, beans and peas. There are also some apple orchards in the blocks. Ninety percent of the area is surface-irrigated.

Major soils are Ritzville, Warden, and Burke silt loam comprising 49%, 27%, and 15% respectively of the soils in the block. The remaining 9% is comprised of small amounts of other soils. The Ritzville and Warden soils are silt loams to depths greater than 60 inches and the Burke soil is a silt loam to 30 inches where it rests on caliche hardpan. The available moisture holding capacity of Ritzville and Burke silt loam is 2.6 inches per foot, and Warden silt loam is 3.1 inches per foot.

Irrigation water was first delivered to block 74 in 1954 and block 741 in 1965. Water for these blocks is secured directly from the West Canal and is pumped up to four main laterals that run basically on the contour through the two blocks. Tailwater from the individual farm units is returned either directly to the lateral below it or into wasteways. Two wasteways dump directly into the West Canal and two go under the West Canal with the water being picked up for reuse further downstream.

It is common practice in the study area to irrigate continuously throughout the irrigation season. The common practice is to irrigate one-seventh of the field at one time and change to adjacent rows each 24 hours.

Under this management there is continuous inflow to the study sites and as the data indicates a continuous outflow.

STUDY PROCEDURE

Site Selection and Frequency of Sampling

Water quality monitoring sites were selected with several objectives in mind: (1) To determine the quality of the water entering and leaving the two blocks. Quality is defined by the suspended sediment and turbidity characteristics in this report. (2) To determine water quality entering and leaving an individual field, and (3) To determine effectiveness of desilting basins.

Seven block inflow canal sites and four block outflow wasteway sites were sampled once a week. Five fields were selected for monitoring, three of which were equipped with automatic recorders to determine the quantity of tailwater leaving each field. Water samples were taken of inflow and outflow quality twice a week. Samples also were taken of inflow and outflow water from three desilting ponds twice a week throughout the study period.

Site Descriptions

Locations of sampling sites with respect to the overall study area are shown on Figure 1. A brief description of each site follows:

Site 1. Located at the West Canal, indicative of the water quality diverted by the project.

Site 2. Located at the discharge from the relift pump that delivers water to the four main canals within the study area. Since some tailwater enters the canal between sites 1 and 2, site 2 was selected to represent the water quality delivered to the four main laterals.

Sites 4, 5, 6, and 7. Located at or near the end of the four main supply laterals. Data from these sites show water quality levels at the

end of supply laterals after tailwater from interior farms has been allowed to enter.

Site 9. Located on the West Canal below blocks 74 and 741, and below discharge points of wastewater that originated from within the blocks.

Sites 3, 8, 10, and 11. Located on wasteways leaving the blocks. The wasteways at site 8 and 10 flow directly into the West Canal. The other two wasteways pass below the West Canal.

Site 13/15. A 94-acre field of potatoes. An automatic flow recorder was placed at the outflow point.

Site 143/146. A 60-acre field of spring wheat, also equipped with flow recorder.

Site 90. A 40-acre field of sweet corn and 11 acres of potatoes. Quantities were also determined at the time of sampling.

Site 91. A 42-acre field of winter wheat. Tailwater quantities were determined at the time of sampling.

Site 92. A 68-acre field of sugar beets. A continuous flow recorder was also installed.

Site 1S. A desilting pond immediately below field site 90.

Site 2S and 3S. Randomly spaced desilting ponds.

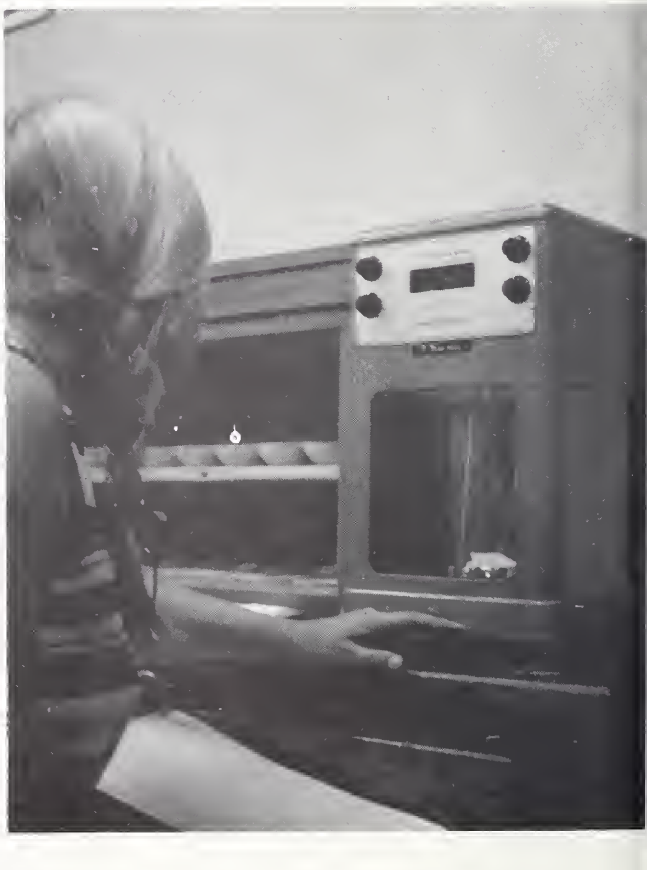
Sample Collection Technique

Water samples were taken by two different methods; (1) the integrated sampler (see opposite page), and (2) the grab sample.

(1) Integrated sampler: Suspended solids that occur in streams will fluctuate according to the velocity, slope of streambed, rising or lowering of the current, turbulence, depth of channel, or any combination of the above. Considering all the variables, the integrated sampler has been designed to collect sediments from all types of streams or lakes. A set of pins are attached to the integrated sampler to keep the nozzle pointed upstream while lowering it vertically into the stream. The nozzle is tilted up to prevent it from coming in direct contact with the streambed. Most streams carry a mixture of both fine and coarse material, and, therefore, variability of concentration within the cross-section. Enough sampling points are established in a cross-section to represent average distribution of different sizes of particles in the stream. On most sites, sampling points were five feet apart on the cross-section.

(2) Grab samples: These consist of half-gallon, large mouth plastic jars placed in stream outfalls to catch one quart of water. This method was used where there was considerable turbulence and thorough mixing resulted and where use of the integrated sampler is not feasible, because of shallow flows: Outlets from individual fields and sediment ponds for examples. In each instance where this method was used, the collection point was at the outfall from a culvert or the outfall from the Parshall flume used in conjunction with the automatic flow recorders.


HACH



Laboratory Testing

In the laboratory, two tests were performed on water samples: For turbidity and suspended solids.

(1) Turbidity: This is caused by suspended matter, such as clay, organic matter, and organisms. The suspended matter causes light to be scattered and absorbed, which is measured in Jackson Turbidity Units (JTU). In the turbidity test, the water sample is shaken well and set for 40 seconds to allow larger particles to fall out. A 25 milliliter sample is taken from the top of the sample bottle and placed into a Hach Turbidimeter. A needle pointer indicates turbidity of the sample.

(2) Suspended solids: The 25 milliliter sample used to determine turbidity is emptied back into the original water sample. Then the sample bottle is emptied into a filter press, 125 psi of air pressure is applied. The sediments are collected on a preweighed filter, oven-dried and weighed. By calculation, the sediments are expressed as milligrams per liter (mg/l) or parts per million (ppm).

ANALYSIS OF DATA

Summary: There appears to be a relatively stable relationship between suspended solids and turbidity under the variety of conditions in the study area regardless of the crop grown and the cultural practices employed. This can be seen from similarity of data represented by the composite study results in Figure 2 and the results from the two sediment ponds, Figures 25 and 31.

Figure 25 illustrates the effectiveness of sediment ponds in reducing suspended sediment. Similarly the ineffectiveness of sediment ponds in reducing turbidity is apparent from Figure 27.

Similar evaluations for other soils and conditions are needed.

Recommendations: This study has shown need for additional data and information on:

(1) Relationship of suspended solids and turbidity from different soils.

(2) Effectiveness of conservation practices on reduction of these two parameters.

(3) Water quantities used versus crop requirements.

Subsequent studies should address these questions either singly or in combination.

Discussion: The dashed line on Figure 2 represents the relationship of suspended sediment to turbidity of the effluent from the sediment ponds 1S and 3S. The best fit line is essentially parallel with the overall study results. This displacement of the line to the left displays the lack of effectiveness of the sediment pond in reducing turbidity. This line is drawn with less credibility as the data was taken from grab samples rather than more reliable techniques. Our intent is merely to show the apparent relationship of "treated

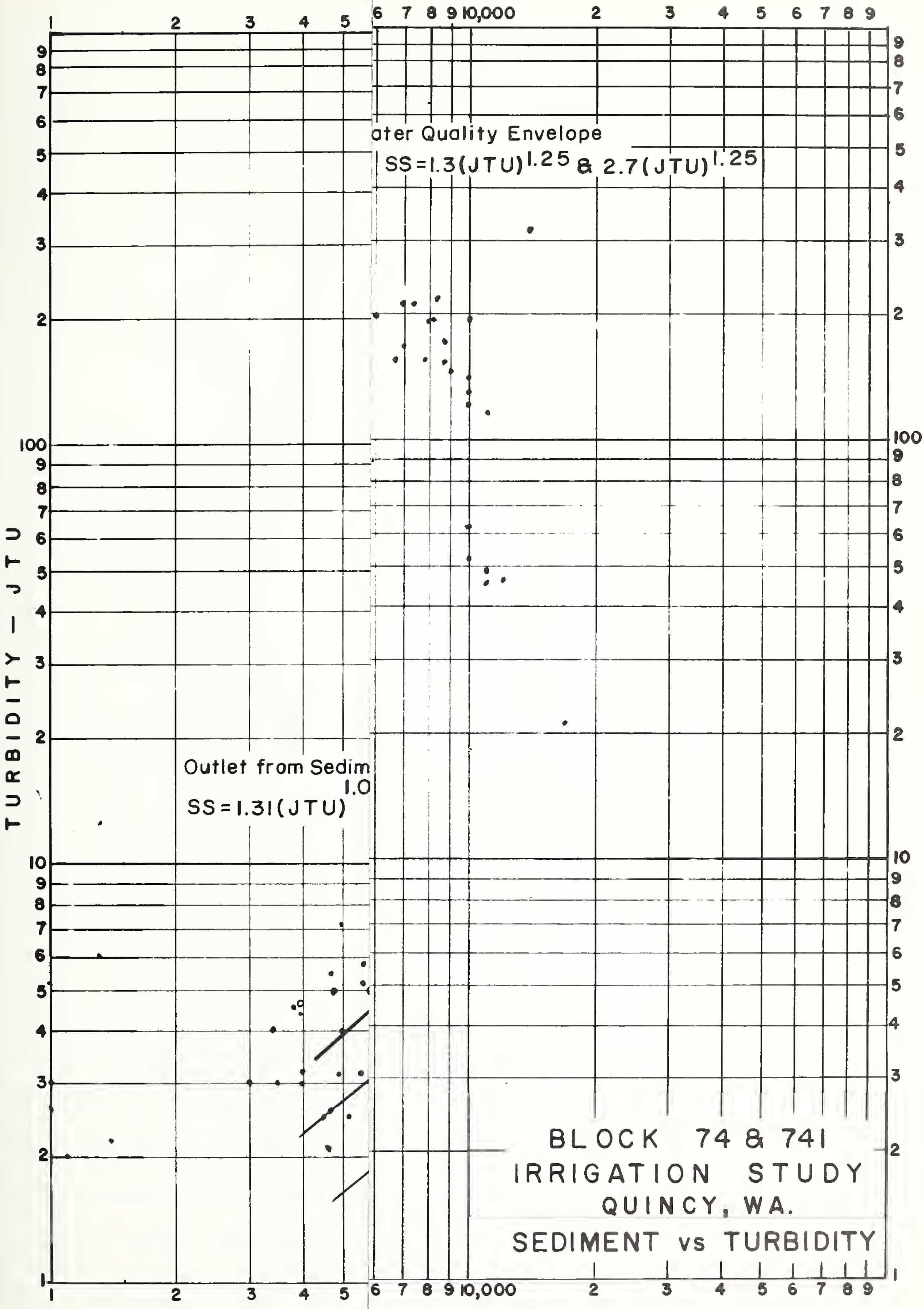

TURBIDITY — JTU
ater Quality Envelope
SS=1.3(JTU)1.25 & 2.7(JTU)1.25
Outlet from Sedim
SS=1.31(JTU)1.0
10,000
BLOCK 74 & 741
IRRIGATION STUDY
QUINCY, WA.
SEDIMENT vs TURBIDITY

Figure 2

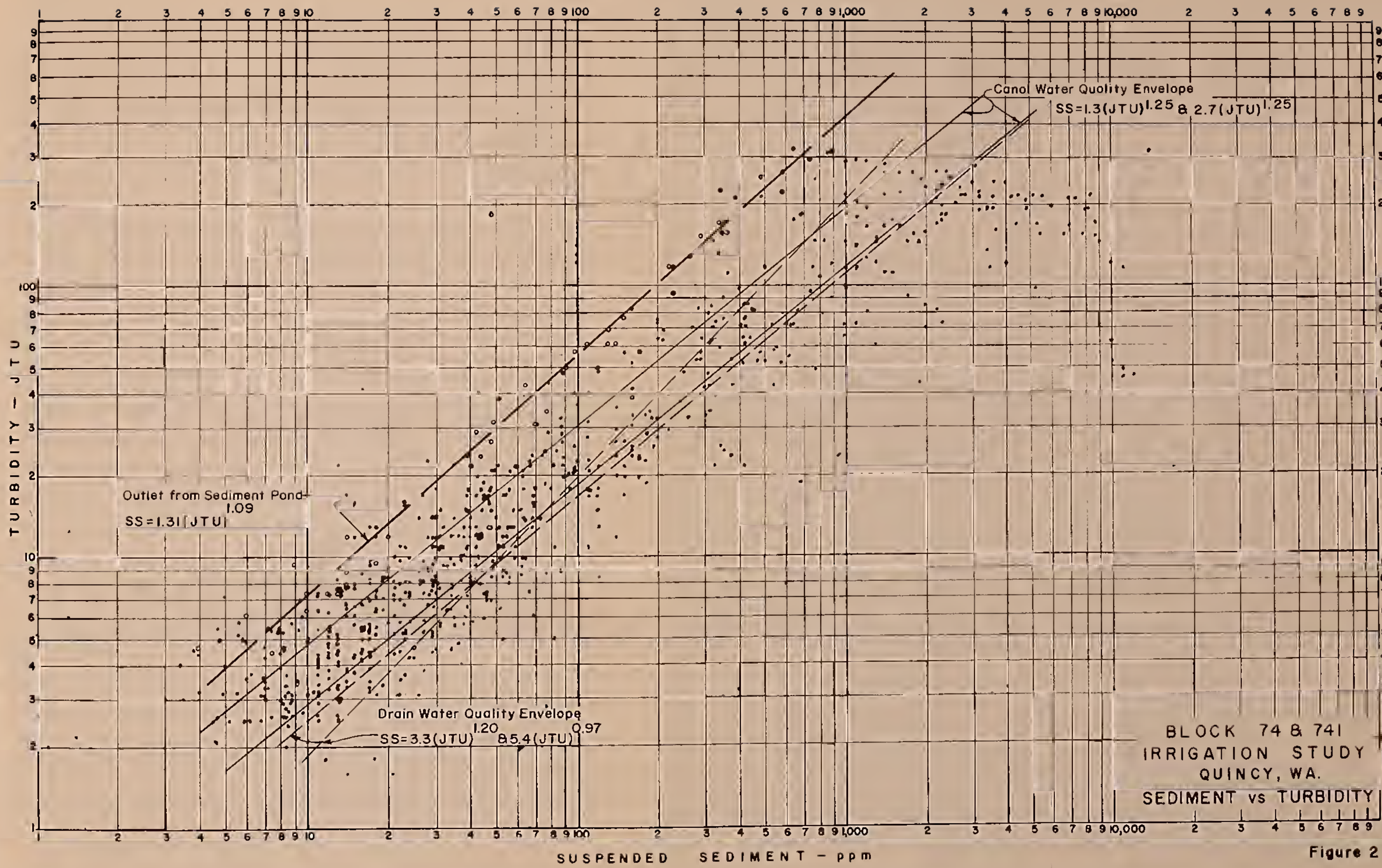

Canal Water Quality Envelope
SS=1.3(JTU)^1.25 & 2.7(JTU)^1.25
Outlet from Sediment Pond
SS=1.31(JTU)^1.09
Drain Water Quality Envelope
SS=3.3(JTU)^1.20 & 5.4(JTU)^0.97
TURBIDITY — JTU
SUSPENDED SEDIMENT — ppm
BLOCK 74 & 741
IRRIGATION STUDY
QUINCY, WA.
SEDIMENT vs TURBIDITY

Figure 2

water" to the overall study results. Figures 3 and 4 indicate the suspended sediment and turbidity levels above and below the study area on the West Canal. The data illustrates what would be expected, namely that the water below the study area is higher in suspended sediment and turbidity than it is at the head of the area, except perhaps for the simultaneous occurrence of highs and lows.

Also worth mentioning here and repeated in subsequent graphs involving time is the rather sharp decline in both suspended sediment and turbidity in early August, and the leveling off in late August.

Figures 5 and 6 show a comparison of water supplied to the blocks both at the high and low ends of the internal supply canals. Site 2 represents water quality delivered to the blocks while all other plots show water quality near the end of the supply laterals. Site 5 on the uppermost canal with very little tailwater entering it shows very little deterioration of water quality and in some instances shows improvement. Sites 4, 6, and 7 show tremendous increases in suspended solids and turbidity in June and early July. This corresponds fairly well with the increased water delivery to the block, although the amount of suspended solids and turbidity in the laterals taper off before the water delivery drops appreciably. This indicates that the finer particles are washed out of the surface soil early and subsequent flows do not contribute as much material.

Figures 7 and 8 display the water quality in the wasteways. The general agreement in trends in comparing the two graphs is as anticipated. The water quality in these four wasteways bear a relationship to the size of the drainage area they serve and the type of water entering it (i.e., tail-water or lateral spill water). Site 3, with the greatest number of suspended

solids and highest turbidity, has the largest drainage and is made up almost entirely of tailwater. Site 10 has the second highest size drainage area and is second highest in sediments. Site 11 has a small drainage area. Site 8 differs from the other three sites in that its water is made up primarily of water that is allowed to spill from the four main laterals. Further, the declining trend in sediment and turbitity concentrations in late August is apparent in this graph as it is in others. This trend is believed to be caused by the "aging" or equilibrium established within the individual fields. It is much more apparent in individual field data.

At the beginning of this study it was thought that there may be some correlation between quantity of flow and the quality parameters chosen. We found none, as Figure 9 illustrates.

Figures 10 thru 14 show inflow and outflow turbidity levels for the five fields studied. Inflow levels remained relatively constant for each field while outflow levels fluctuated drastically. Again, the decline in the turbidity levels in August, or near the end of the season is quite apparent.

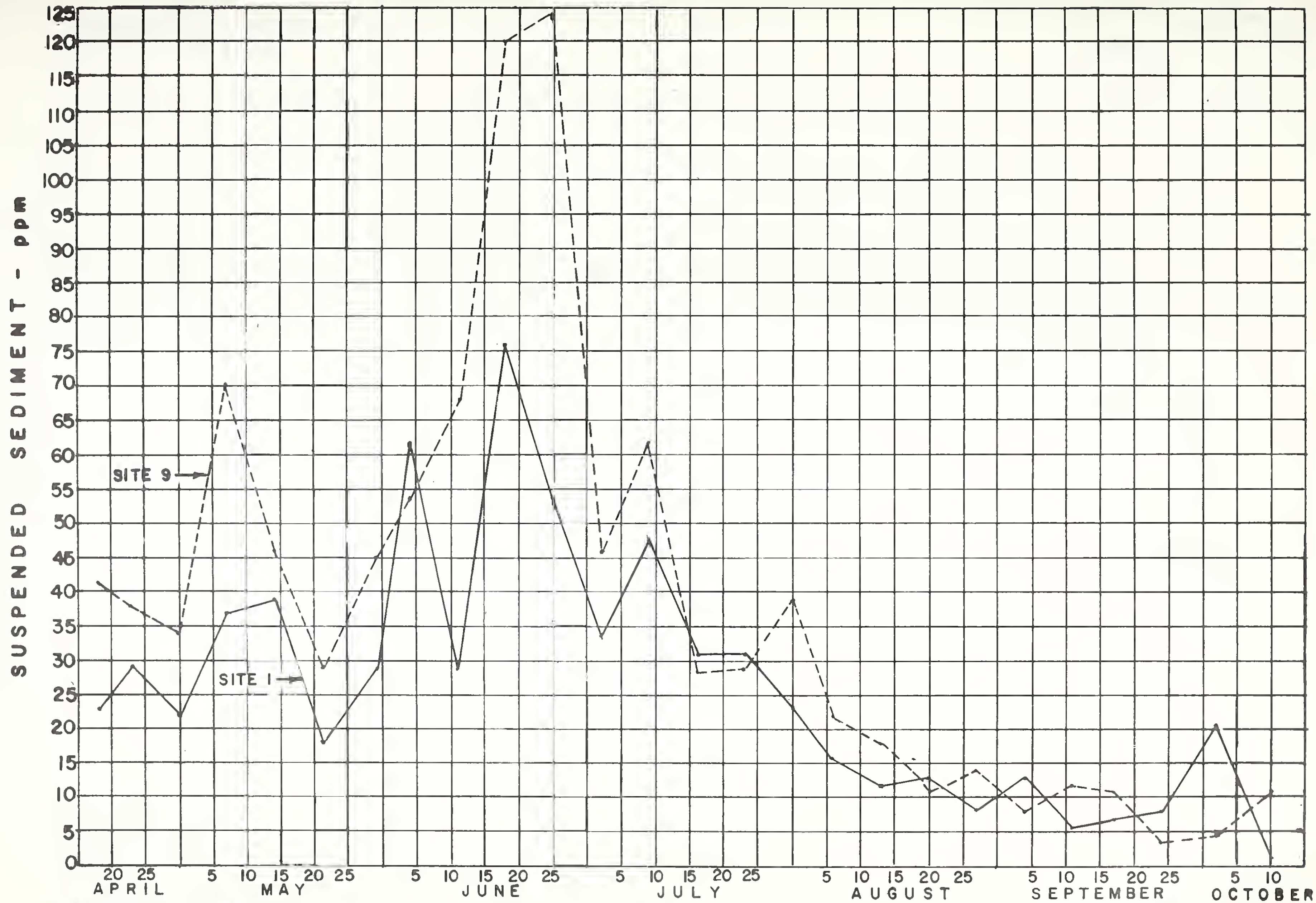
Figures 15 thru 19 show suspended sediment levels for the same measuring points discussed above. The declining trend is readily apparent here too.

The next series of graphs, Figures 21 thru 25 represent inflow/outflow data for pond 1S located below field unit 90. While turbidity appears quite erratic throughout much of the irrigation season, it is important to note the relative magnitudes of the inflow and outflow values, i.e., there isn't a great deal of difference in inflow vs. outflow, see also Figure 21. Suspended sediment on the other hand shows a marked reduction in sediment leaving the pond over that entering exemplified by Figure 22.

Note also the close agreement of the relationship of suspended sediment to turbidity for this pond and the study as a whole.

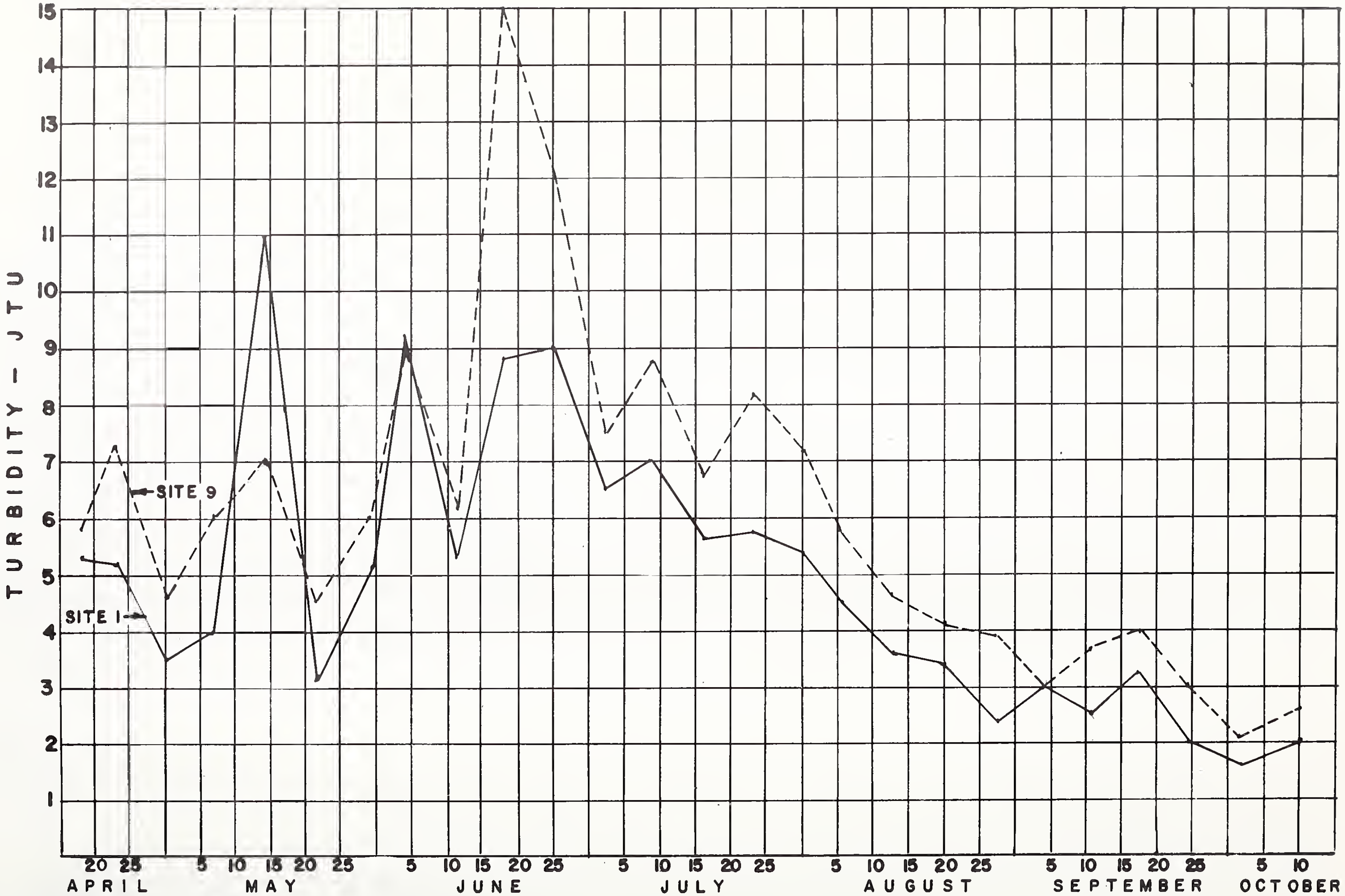
Figures 27 thru 29 are similar data for pond 3S. The lack of correlation in the turbidity levels of inflow and outflow is also noted here. Similarly, the relative good correlation between suspended solids and turbidity data and overall project results is encouraging.

Figure 30 represents an estimate of soil loss per acre from fields of these four crops. These figures are not precise, but their magnitudes are interesting.



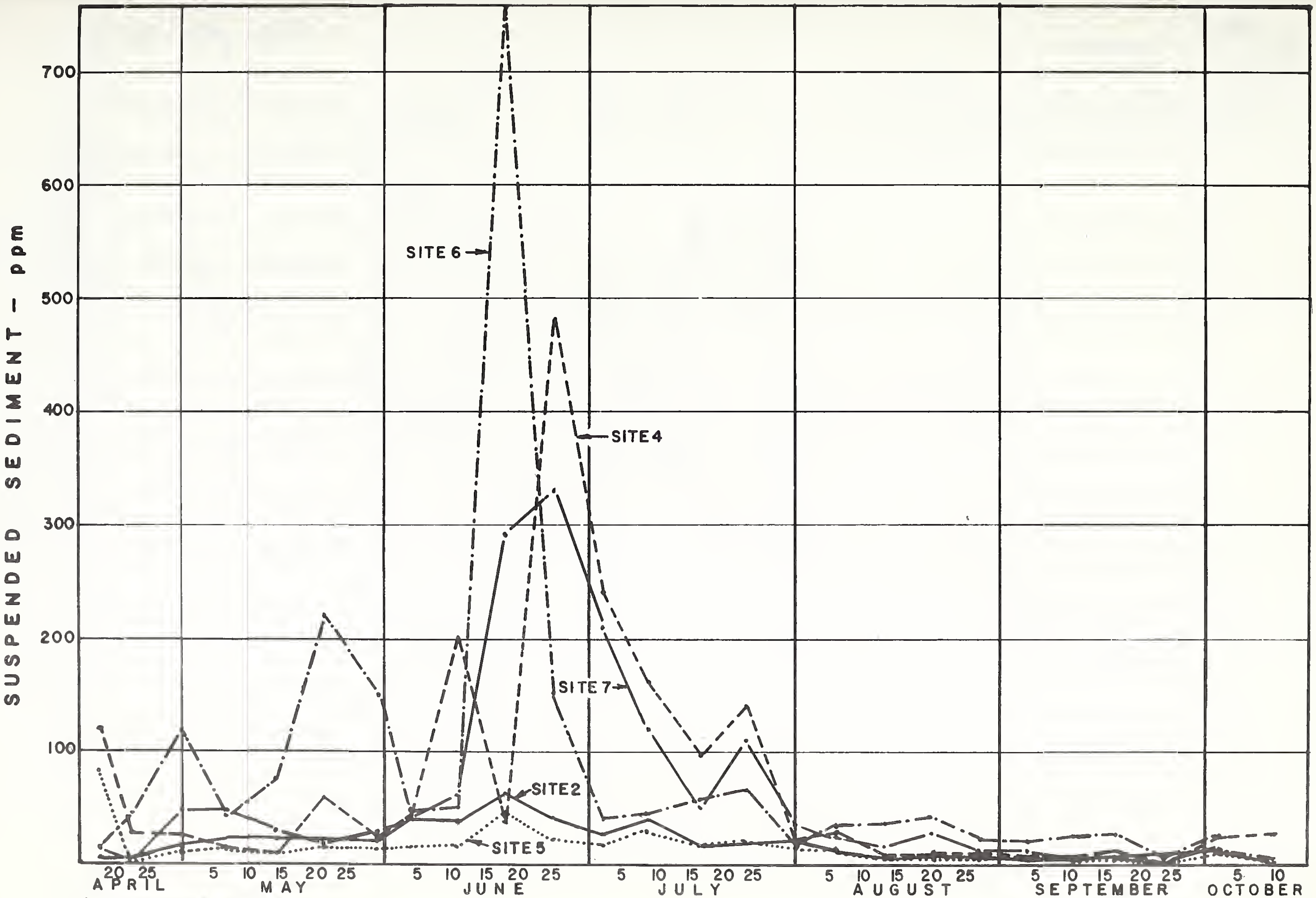
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 3



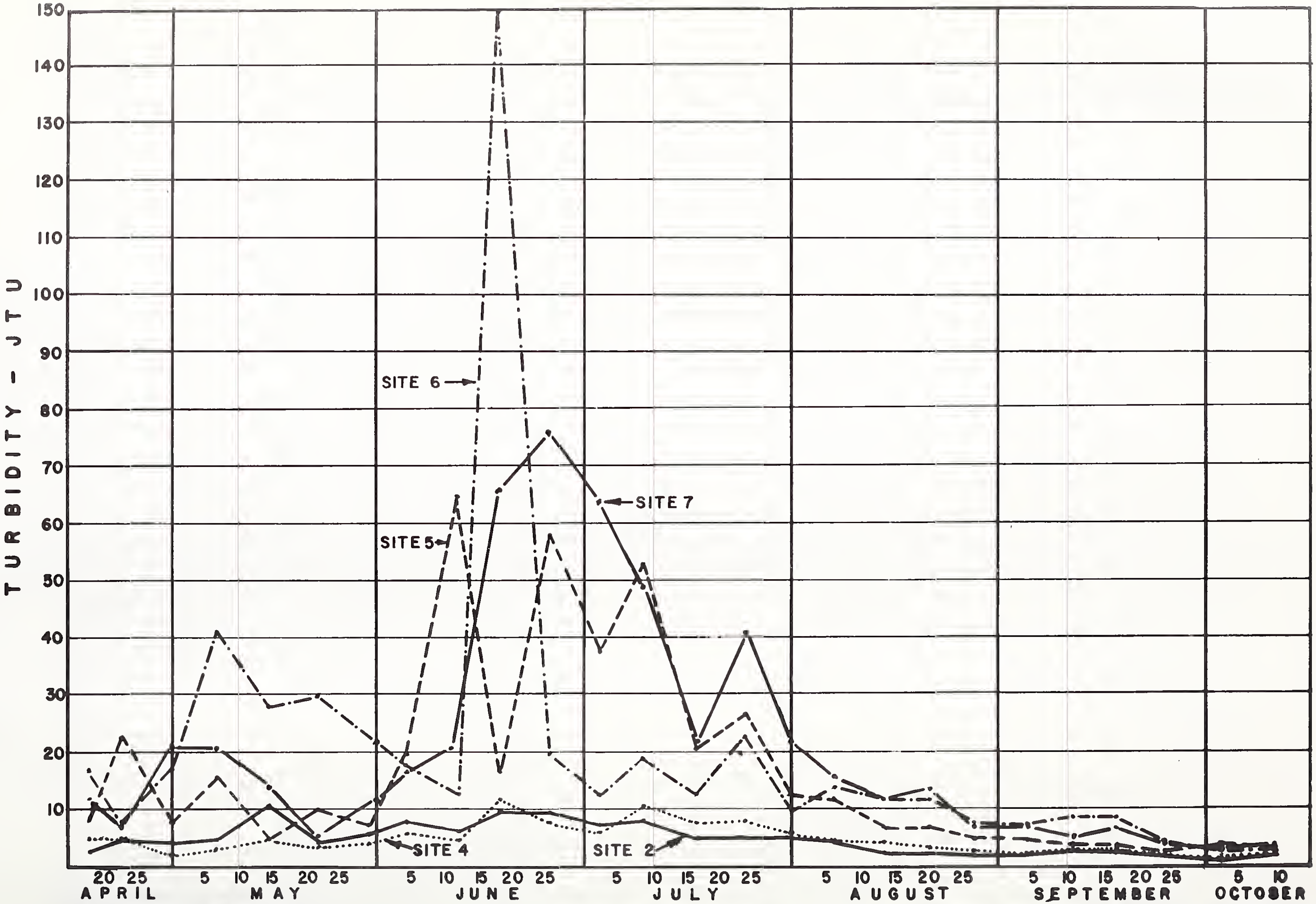
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 4



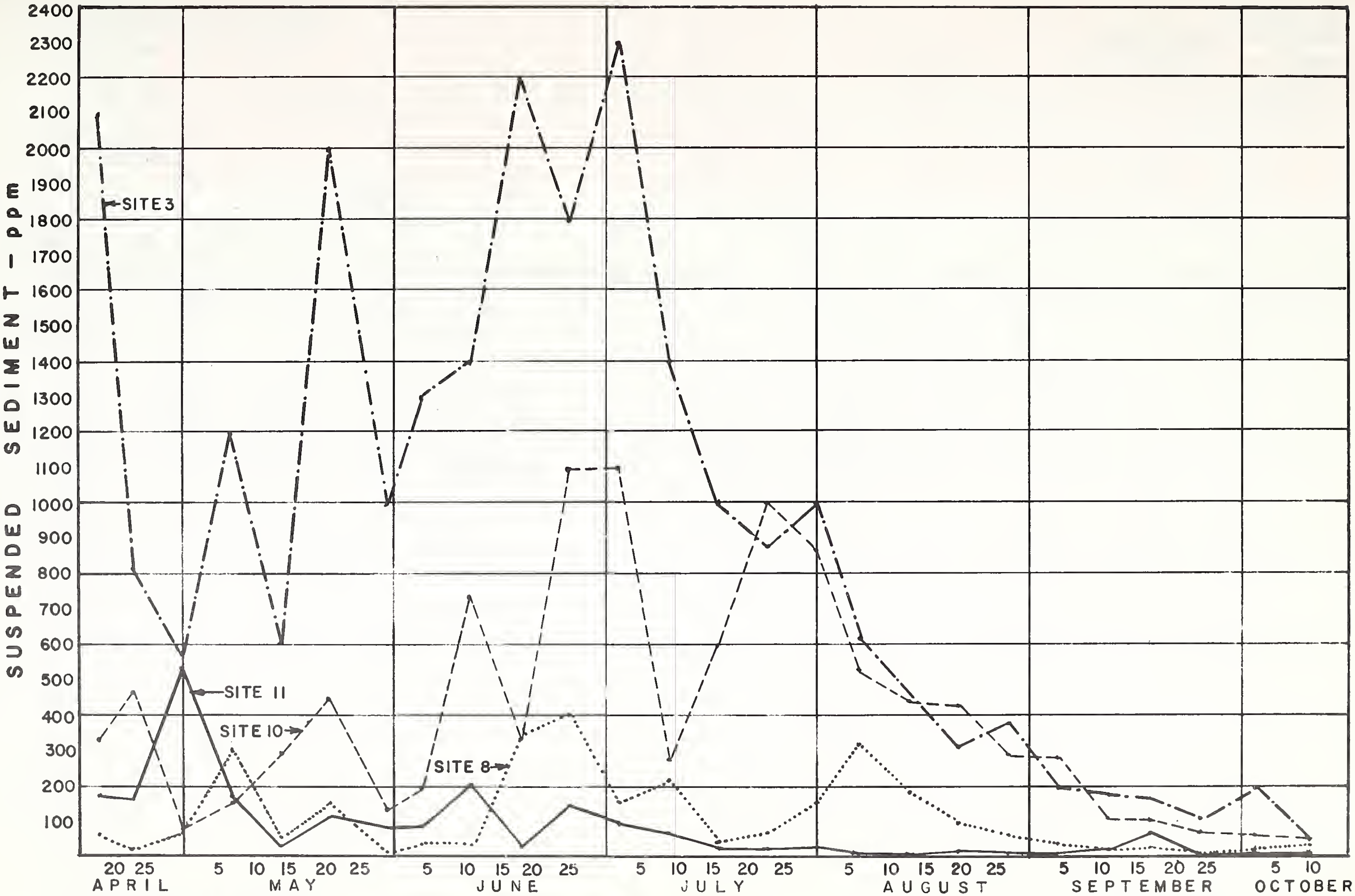
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 5



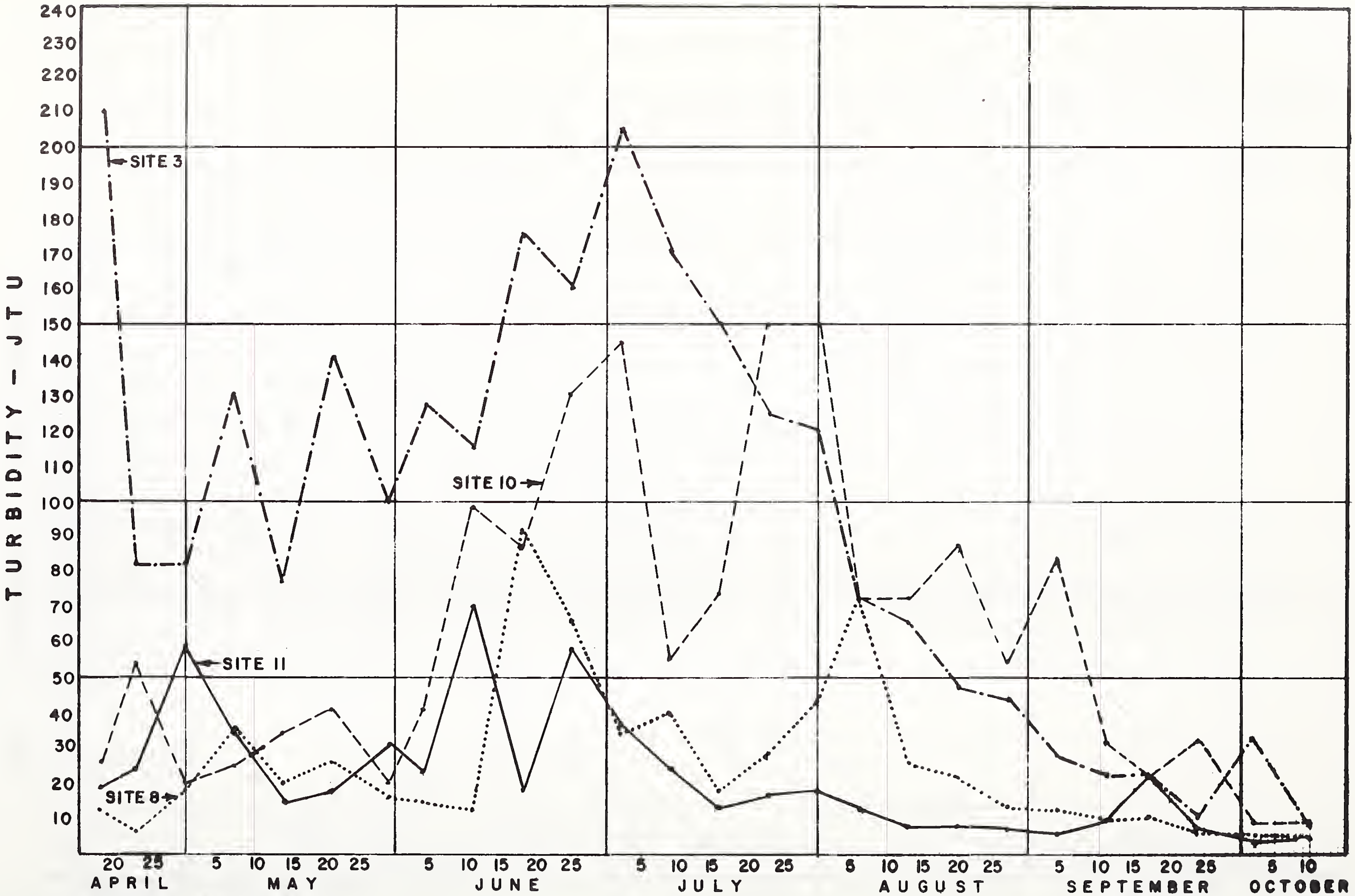
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 6



BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 7



BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 8

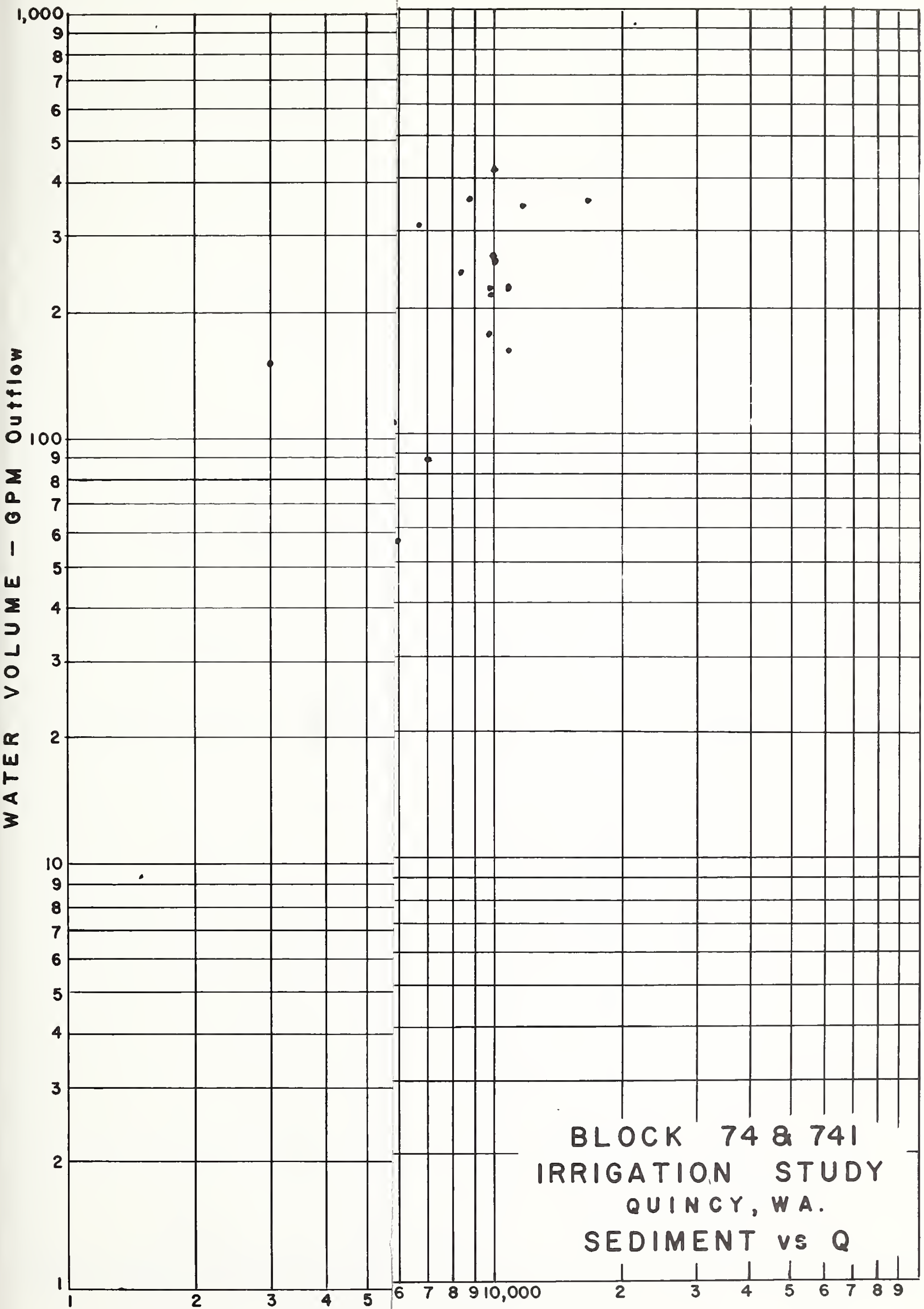

WATER VOLUME - GPM Outflow
1,000
100
10
1
10,000
BLOCK 74 & 741
IRRIGATION STUDY
QUINCY, WA.
SEDIMENT vs Q

Figure 9

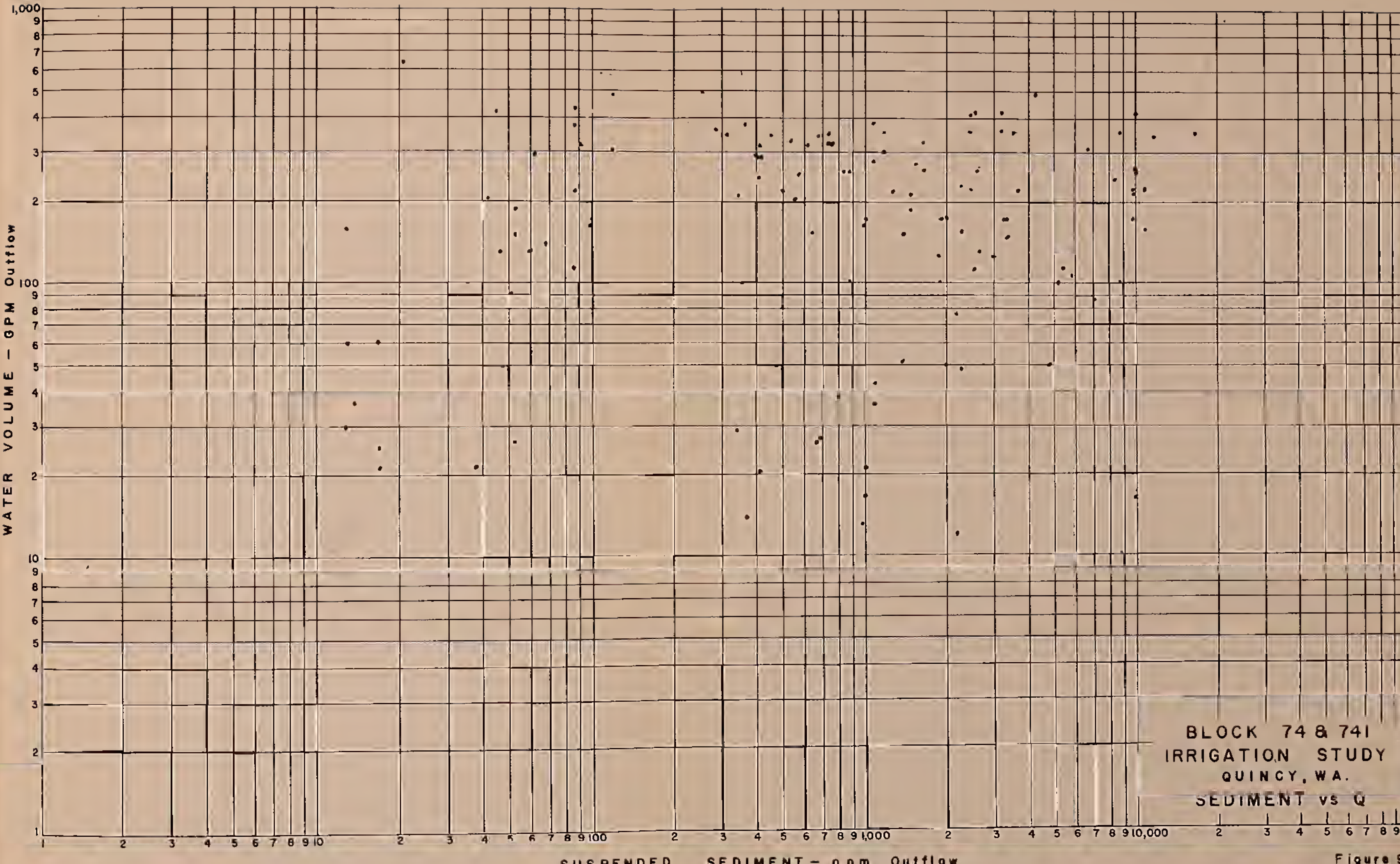
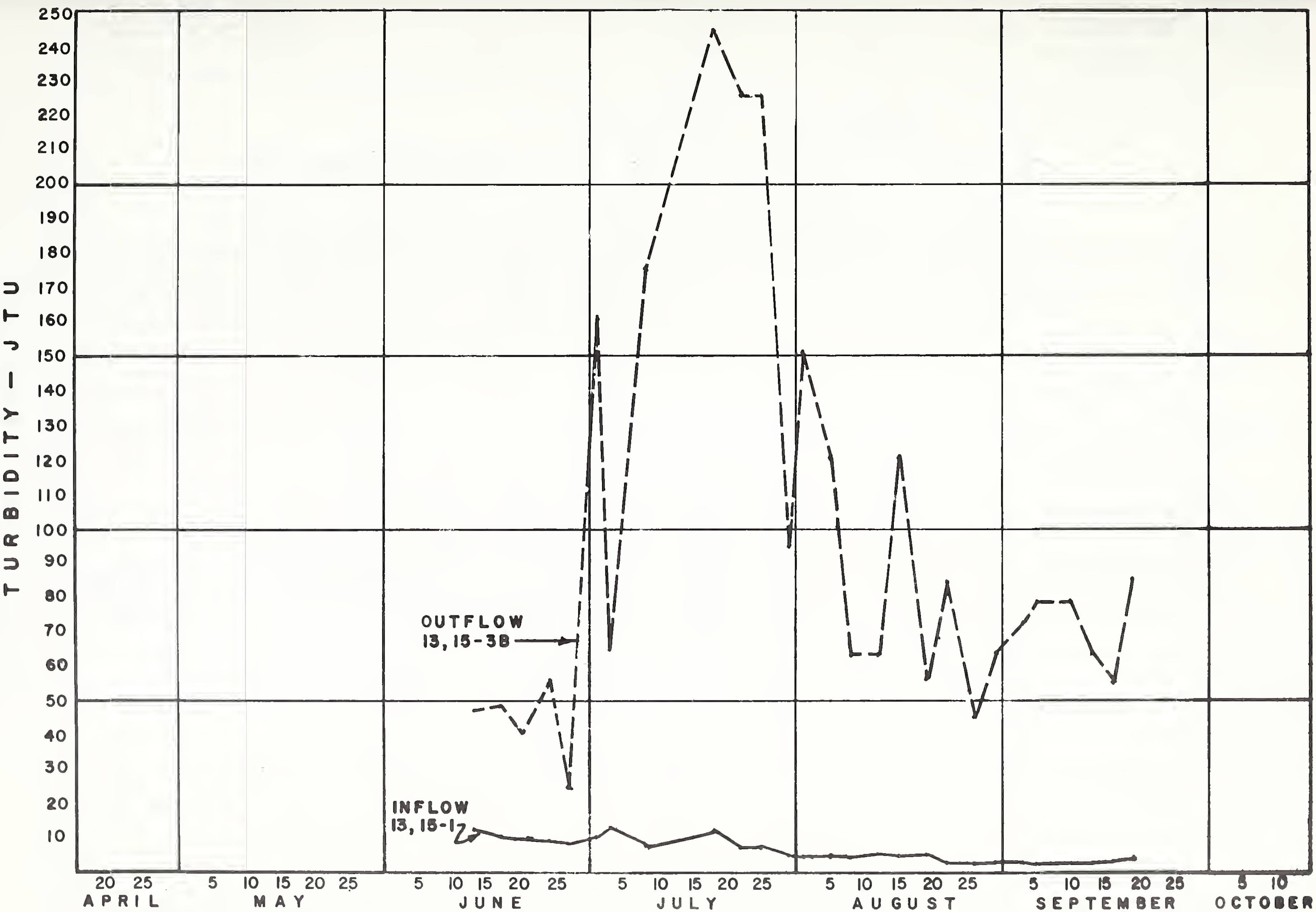
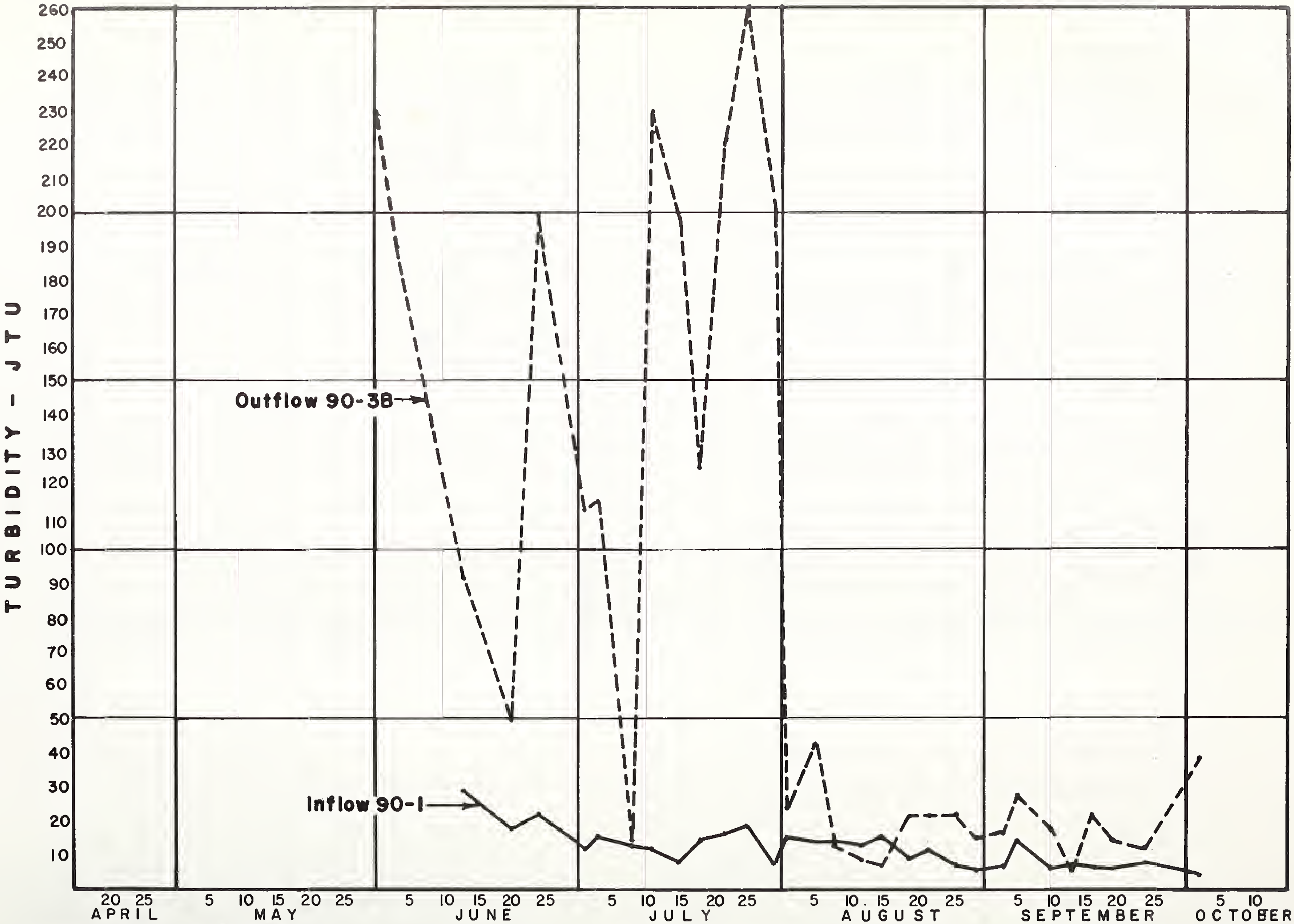

WATER VOLUME – GPM Outflow
SUSPENDED SEDIMENT – ppm Outflow
BLOCK 74 & 741
IRRIGATION STUDY
QUINCY, WA.
SEDIMENT vs Q

Figure 9



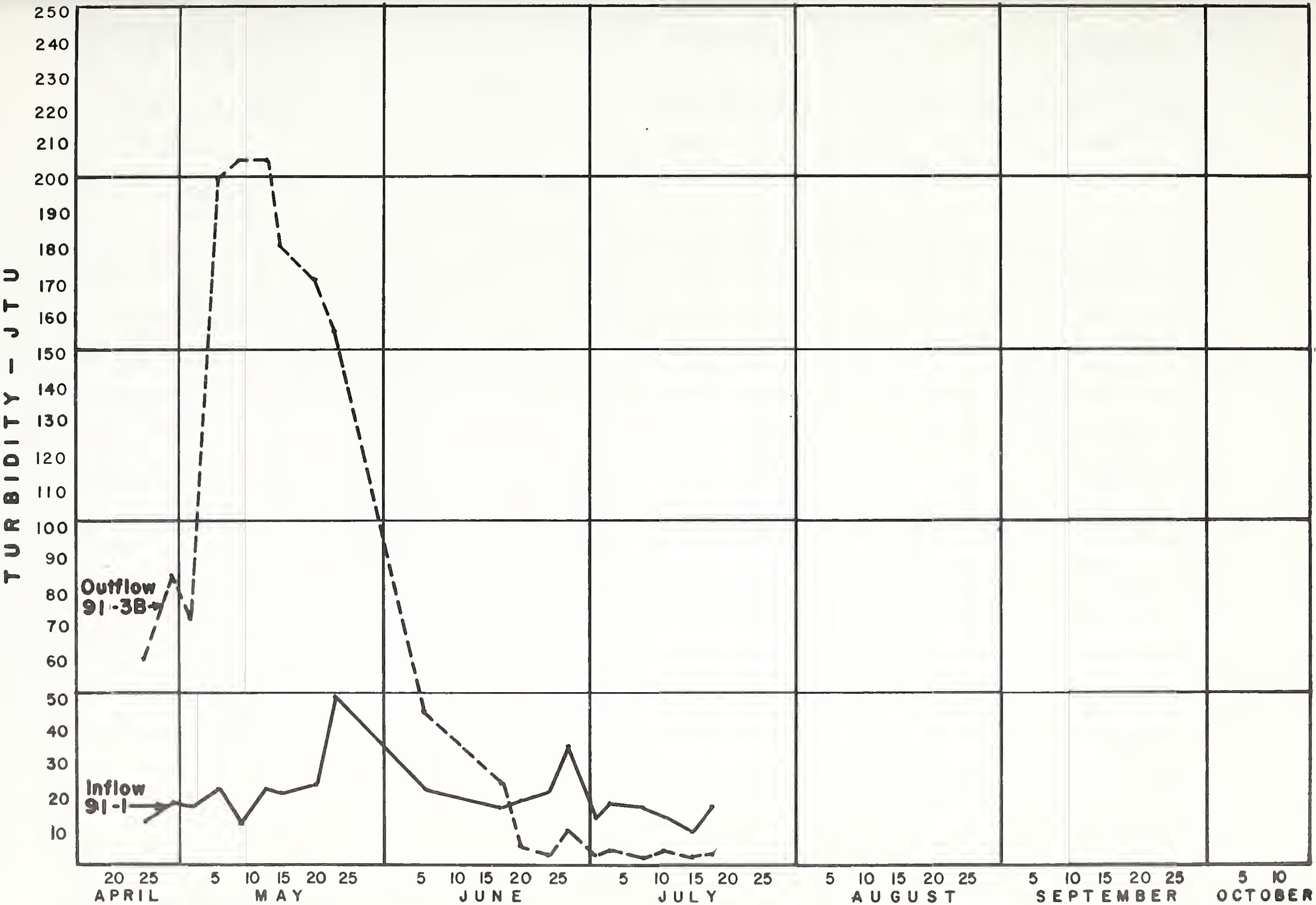
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 10



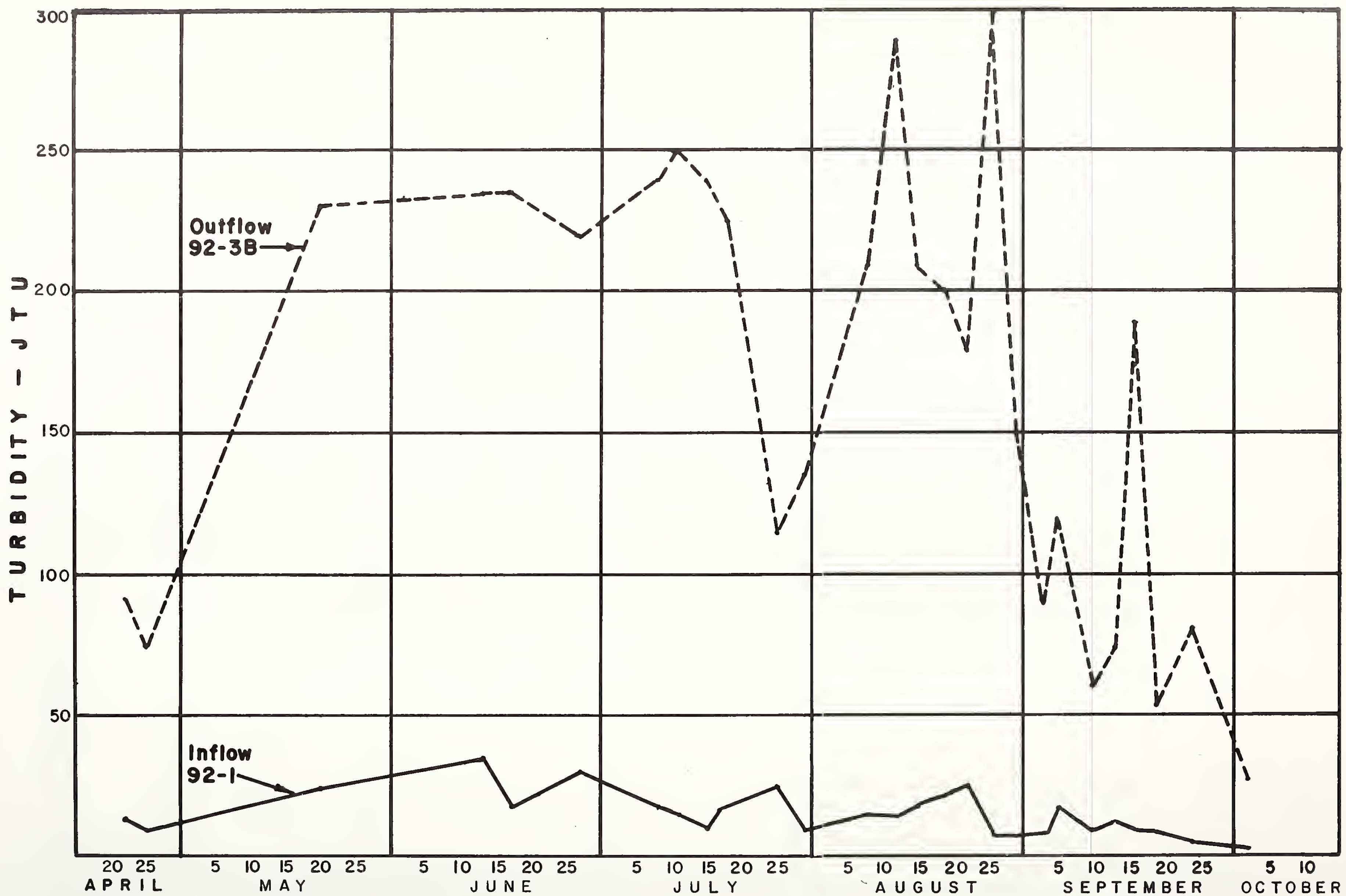
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 11



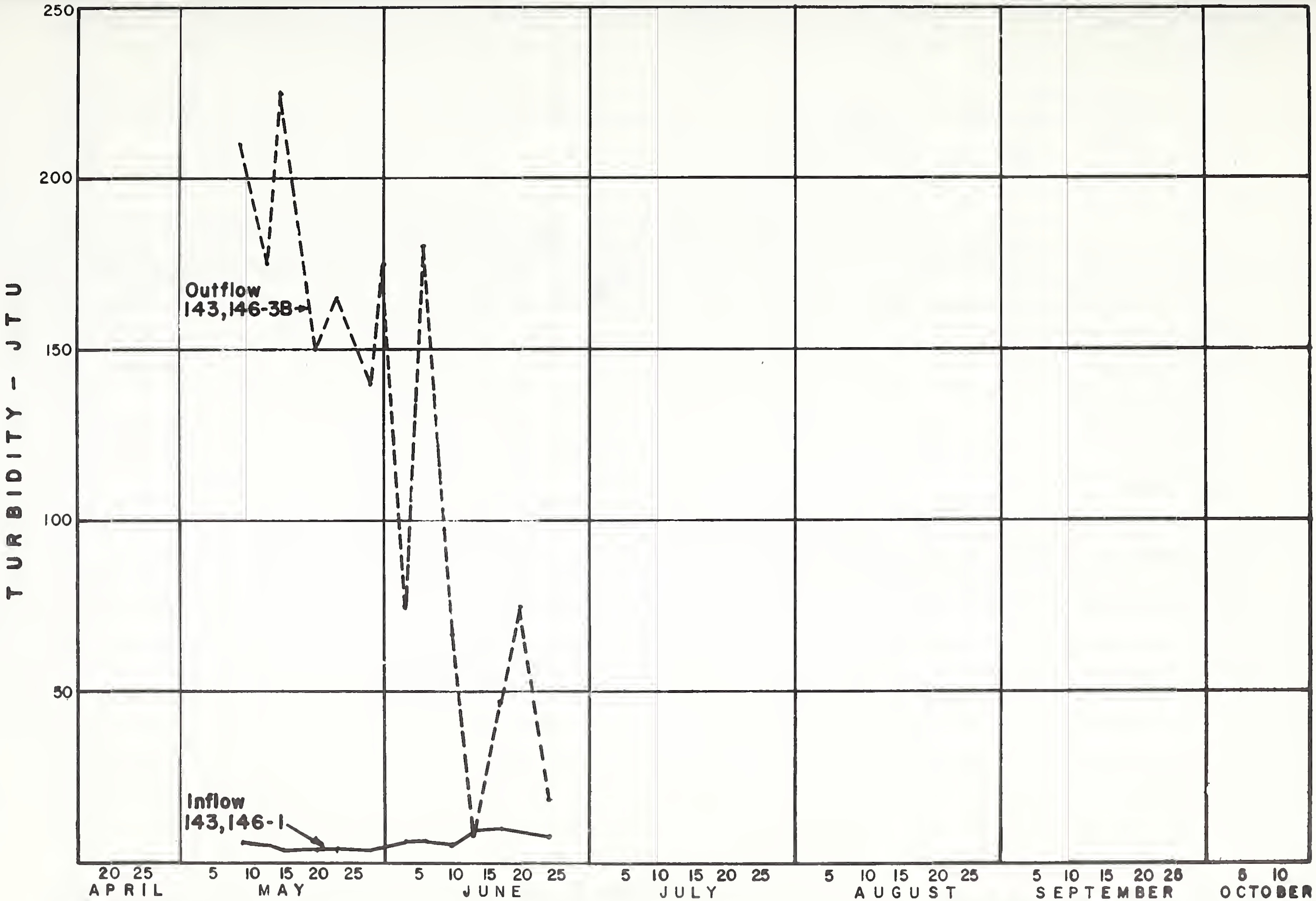
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 12



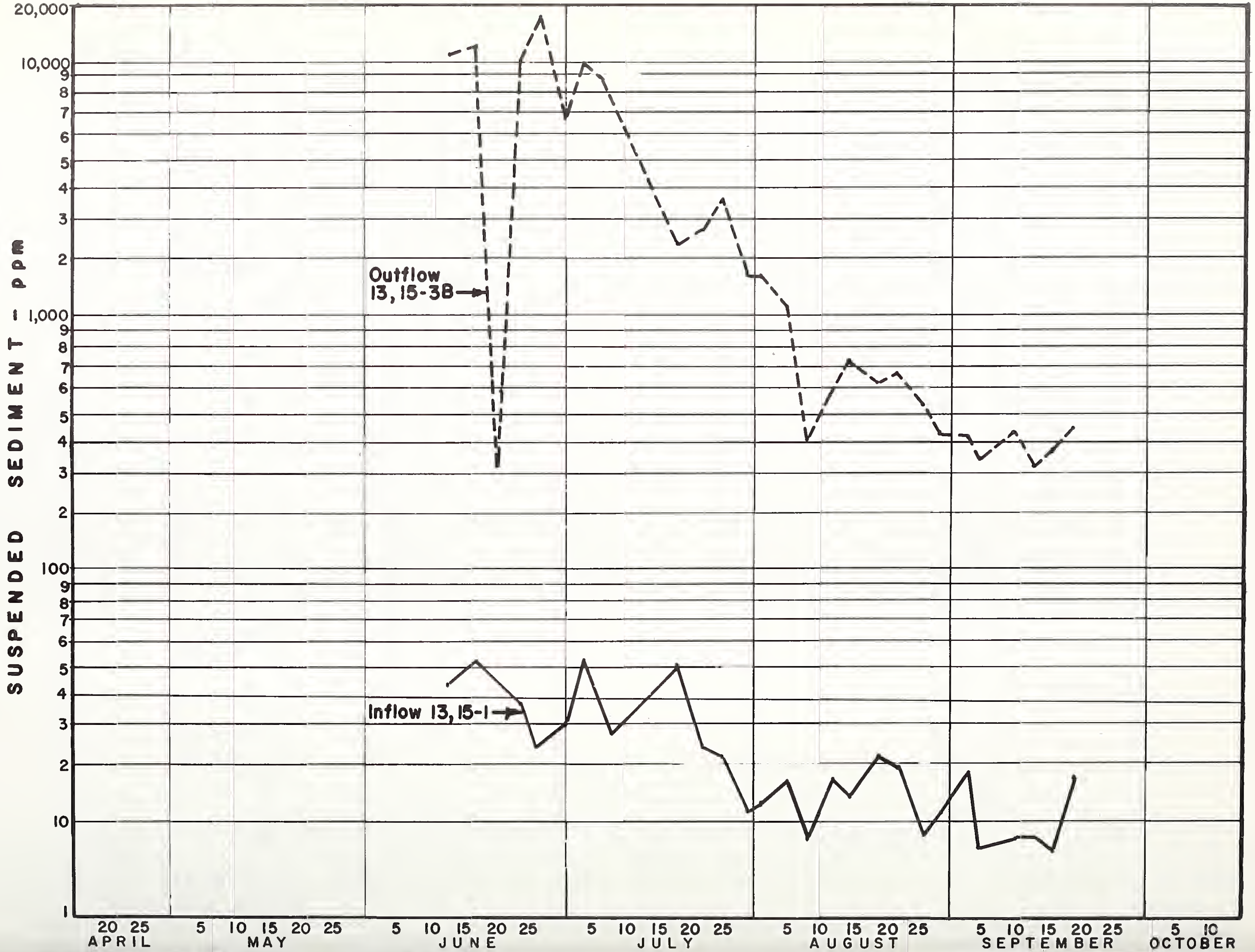
BLOCK 74 & 741
IRRIGATION STUDY

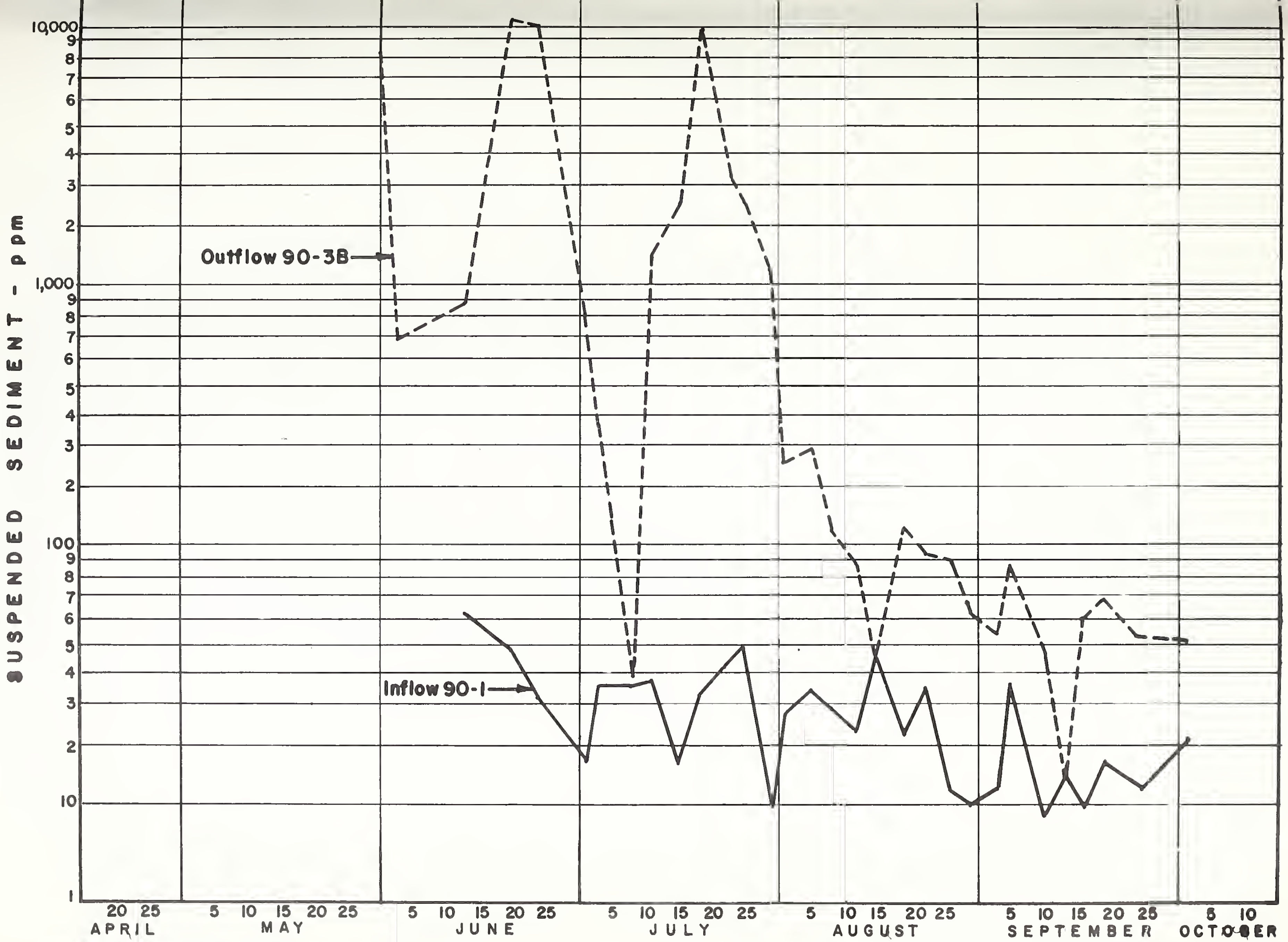
TURBIDITY vs TIME
Figure 13



BLOCK 74 & 741
IRRIGATION STUDY

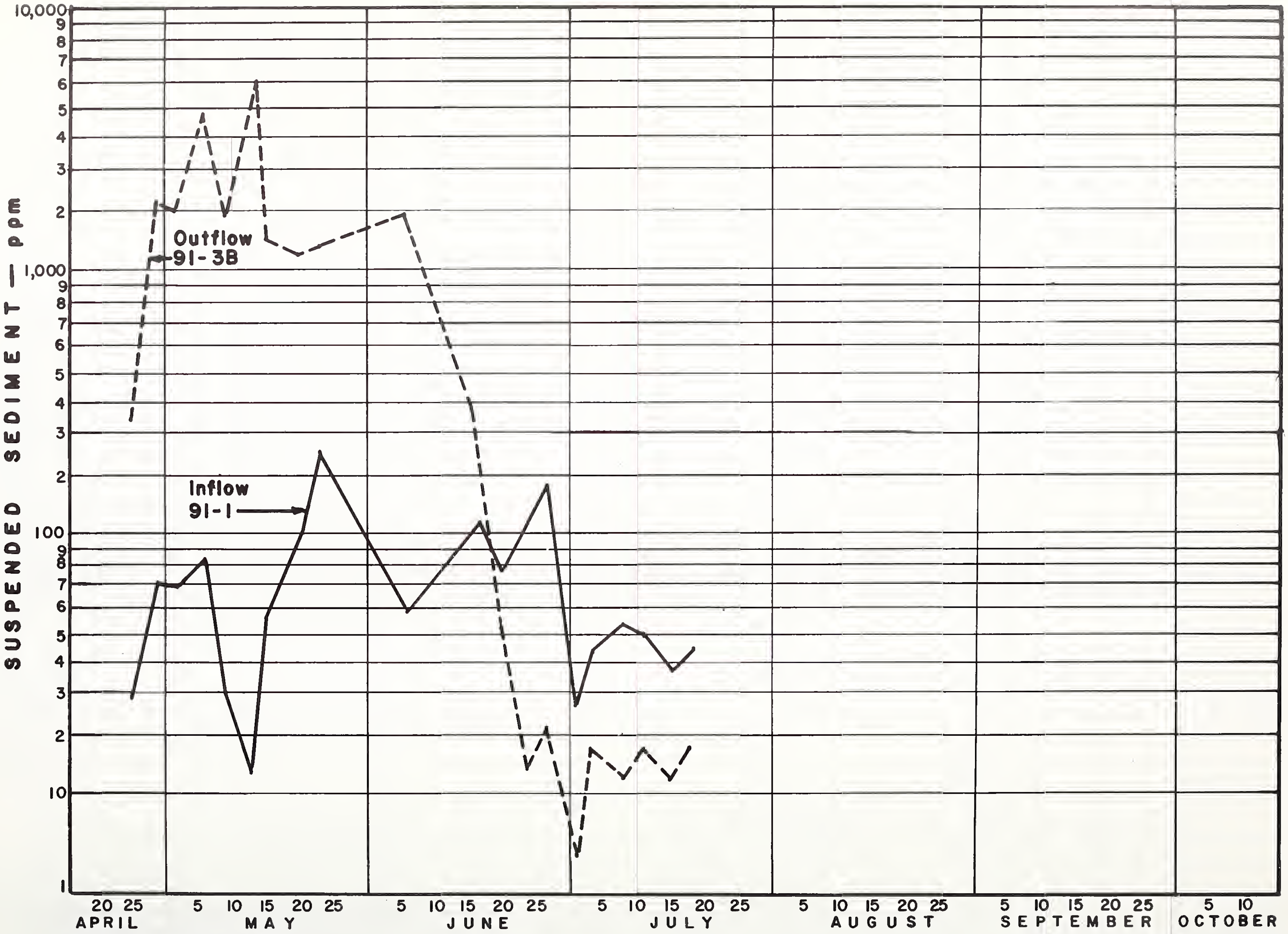
TURBIDITY vs TIME
Figure 14


SUSPENDED SEDIMENT - ppm
20,000
10,000
1,000
100
10
1
Outflow 13, 15-3B
Inflow 13, 15-1
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER



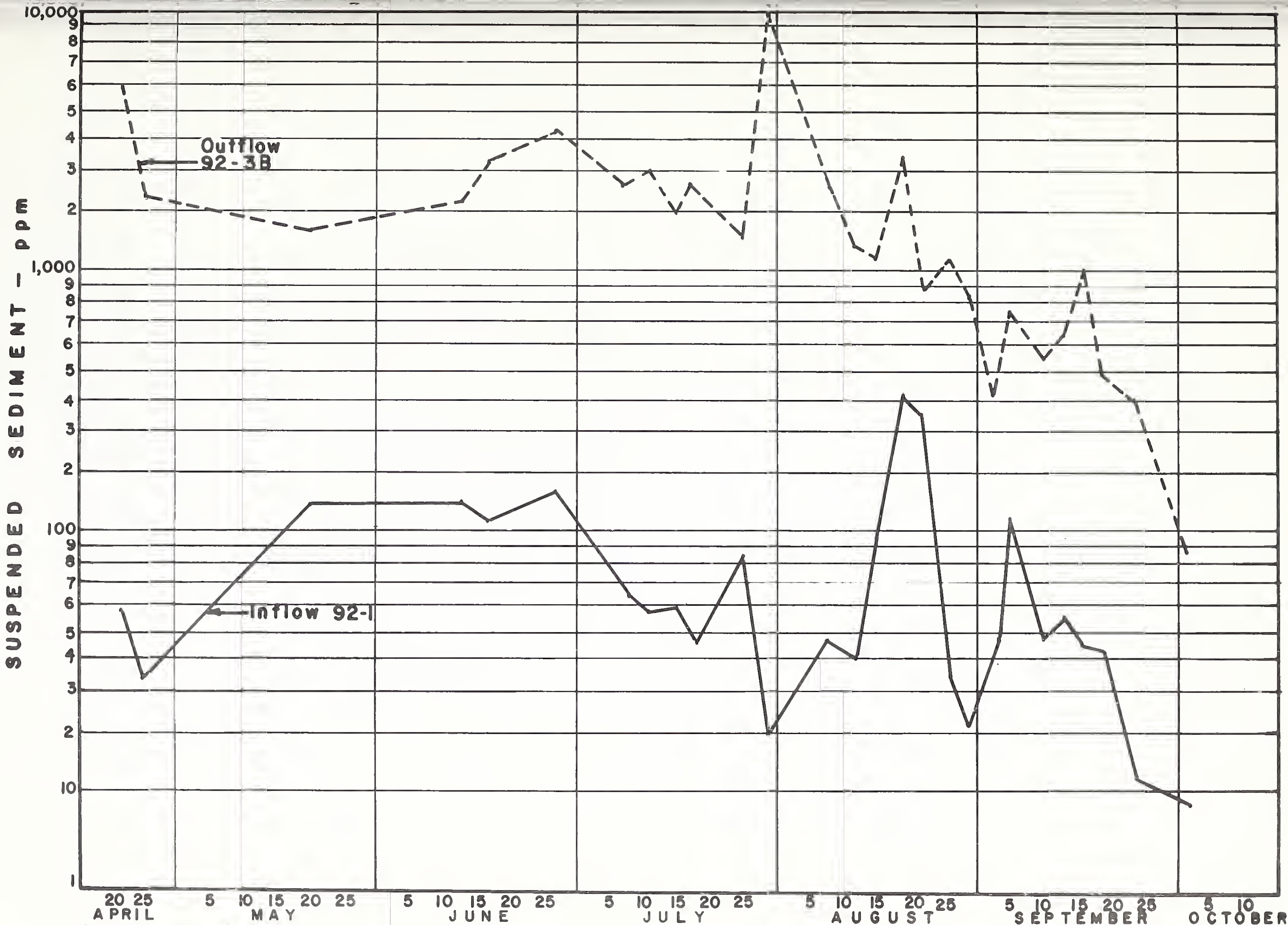
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 16



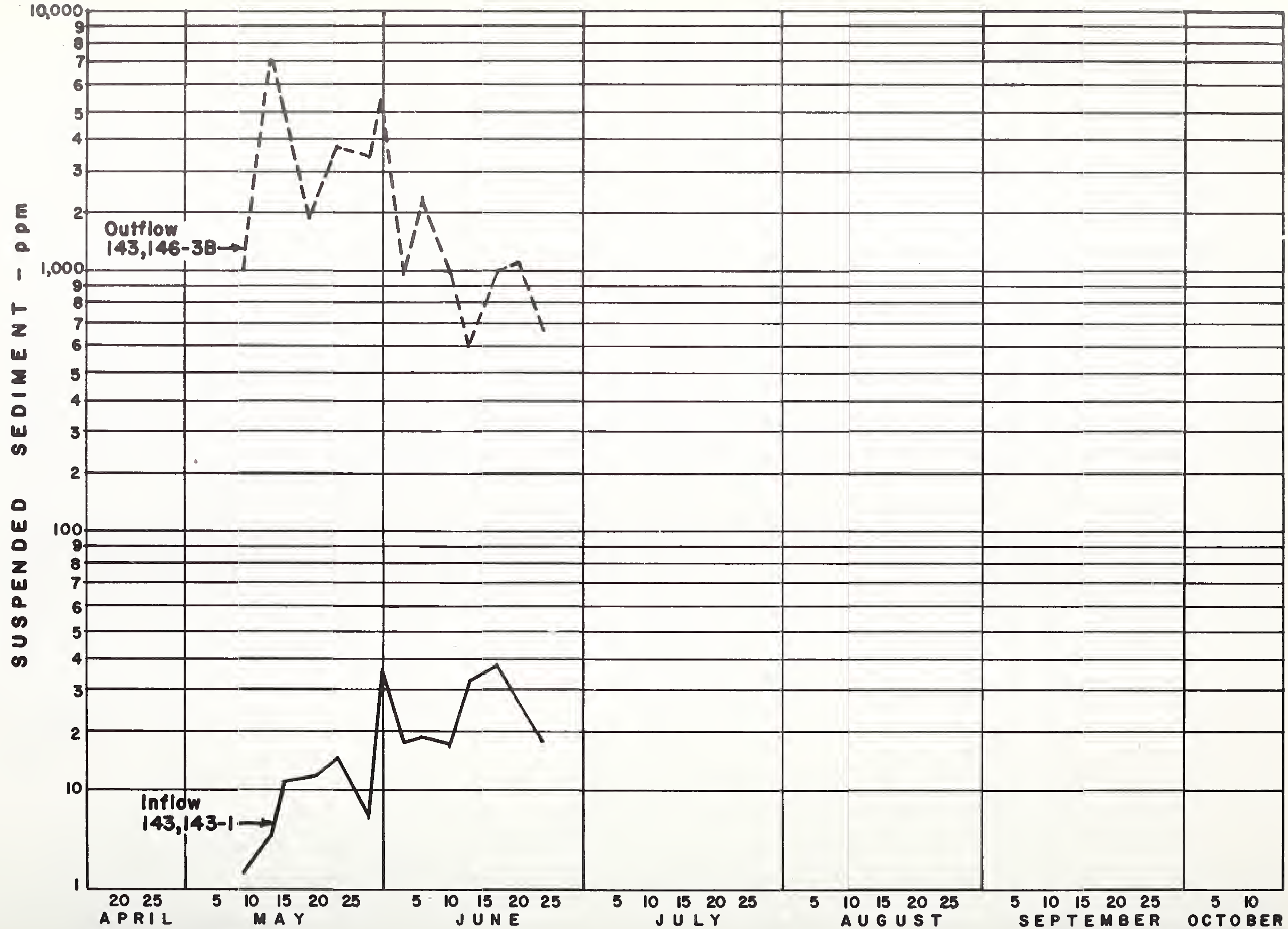
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 17



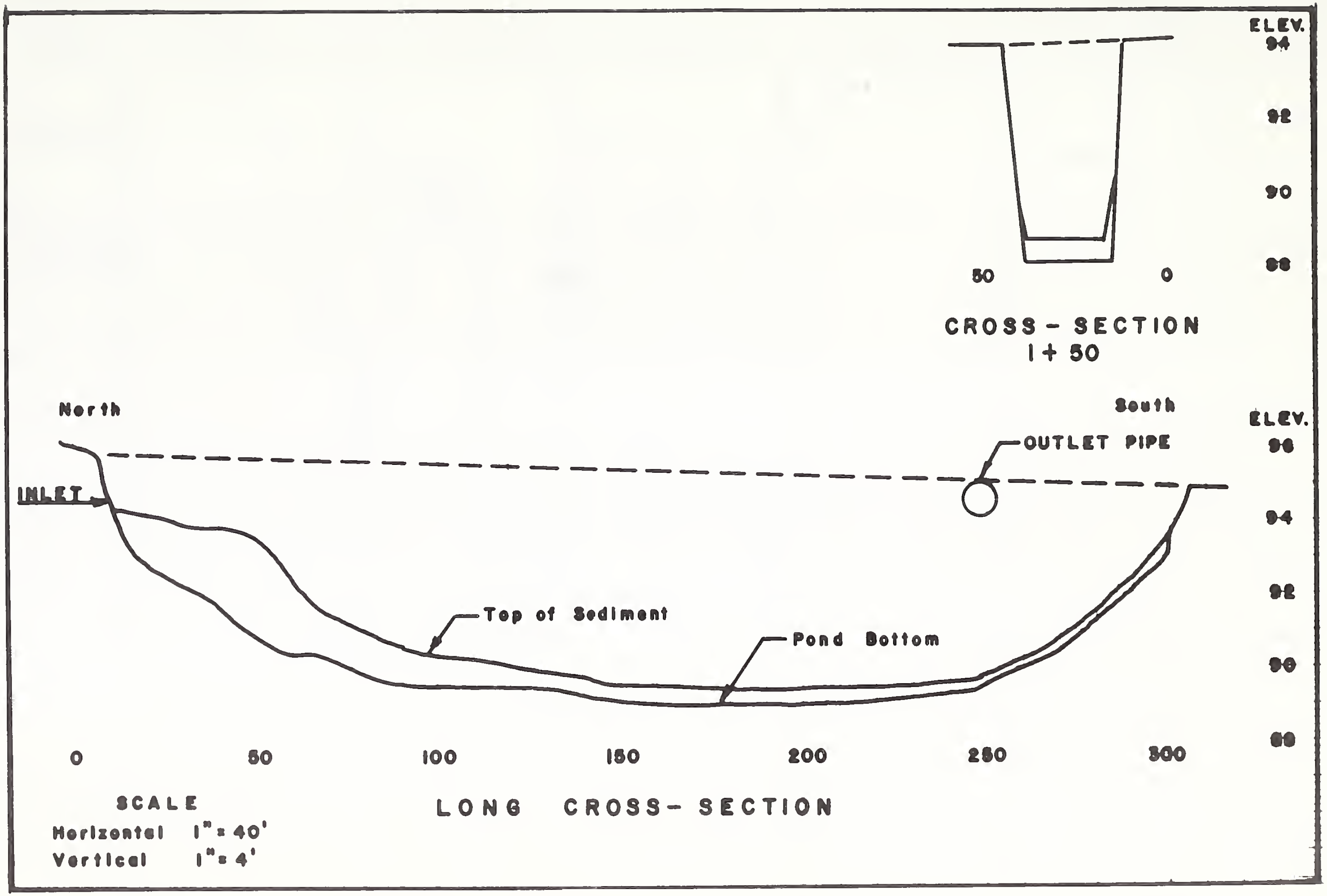
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 18



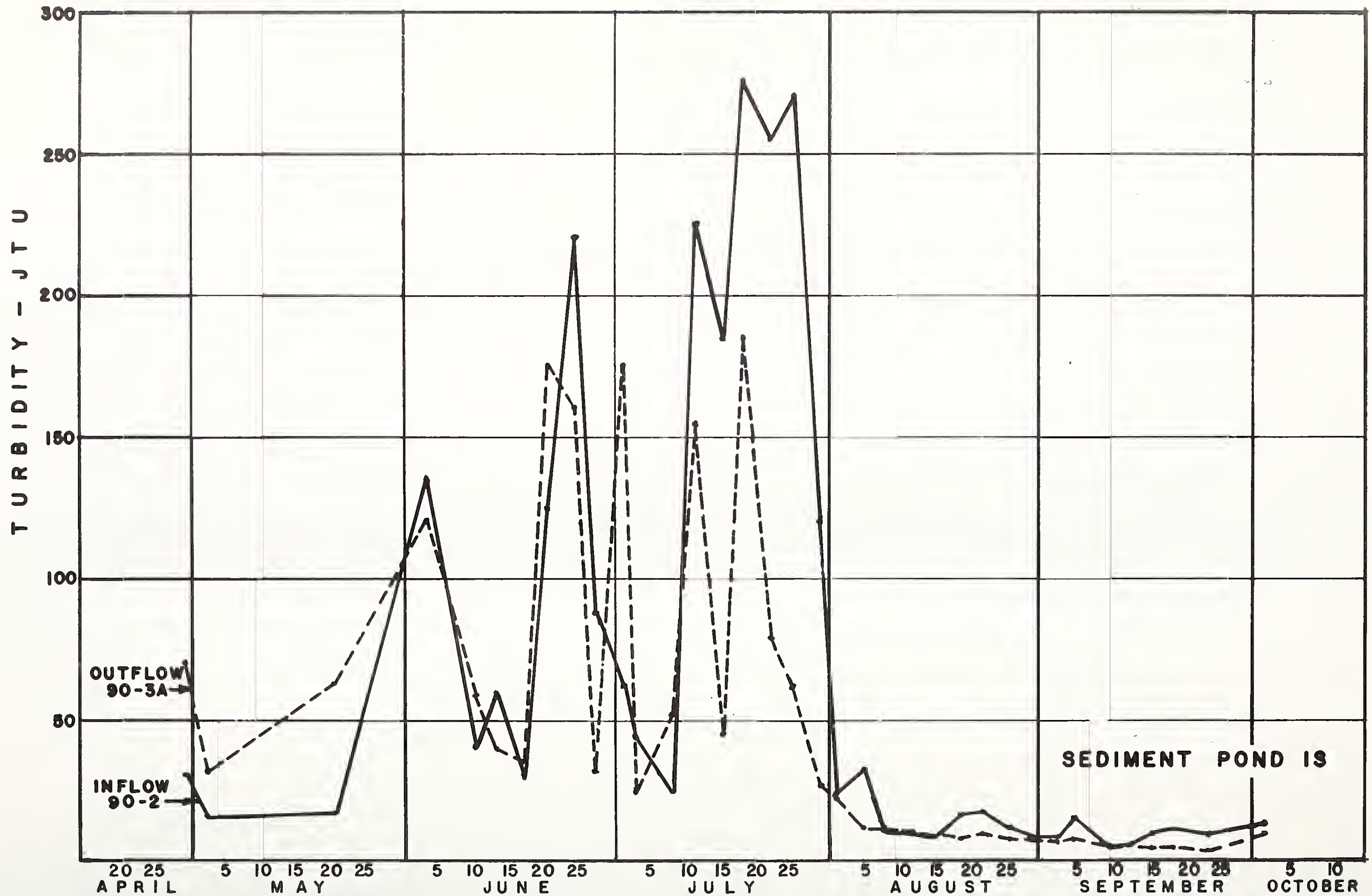
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 19



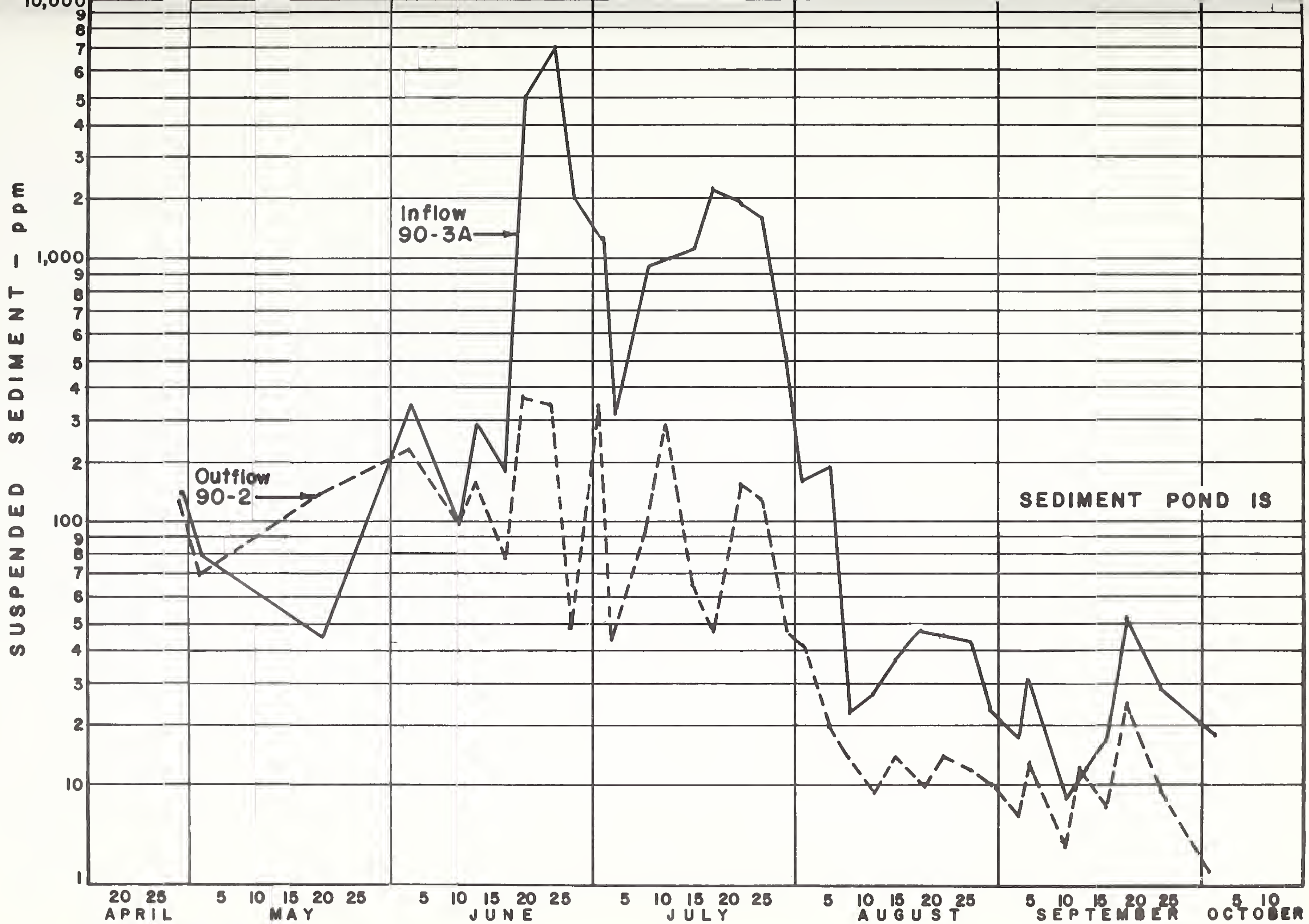
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT POND 18
Figure 20



BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 21



BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 22

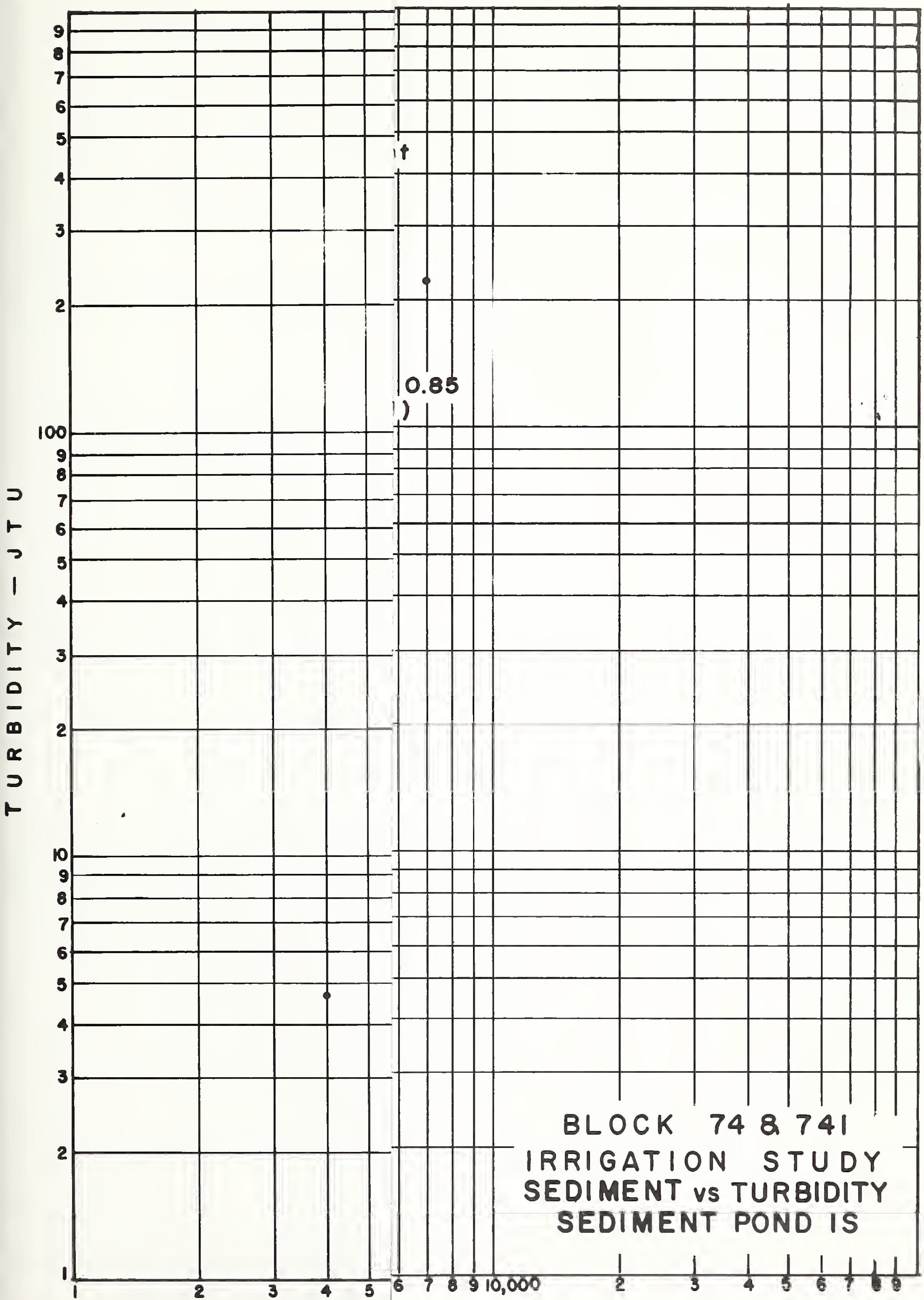

TURBIDITY — JTU
0.85
100
10
10,000
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs TURBIDITY
SEDIMENT POND 1S

Figure 23

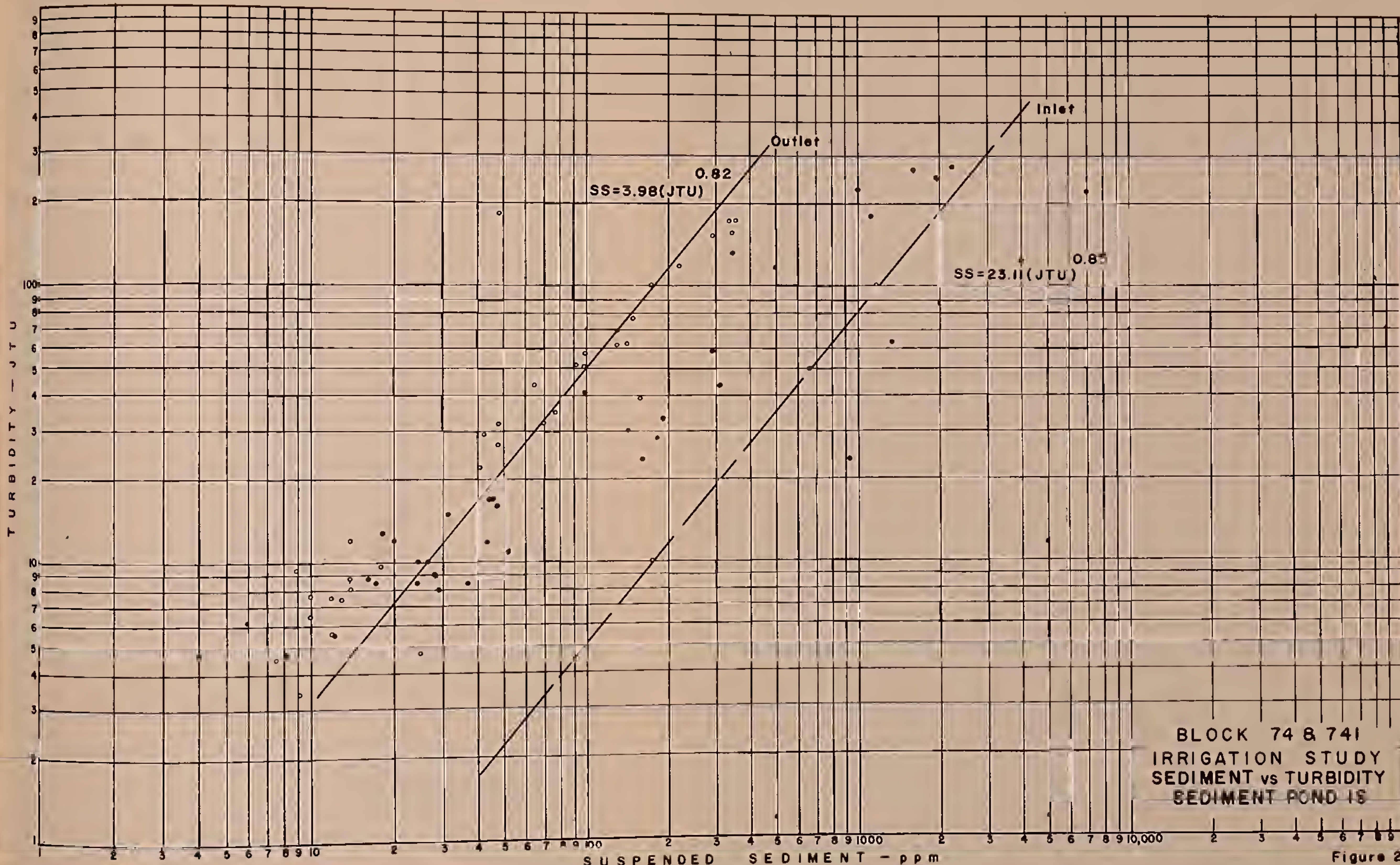

Inlet
Outlet
0.82
SS=3.98(JTU)
0.85
SS=23.11(JTU)
TURBIDITY — JTU
SUSPENDED SEDIMENT - ppm
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs TURBIDITY
SEDIMENT POND 15

Figure 23

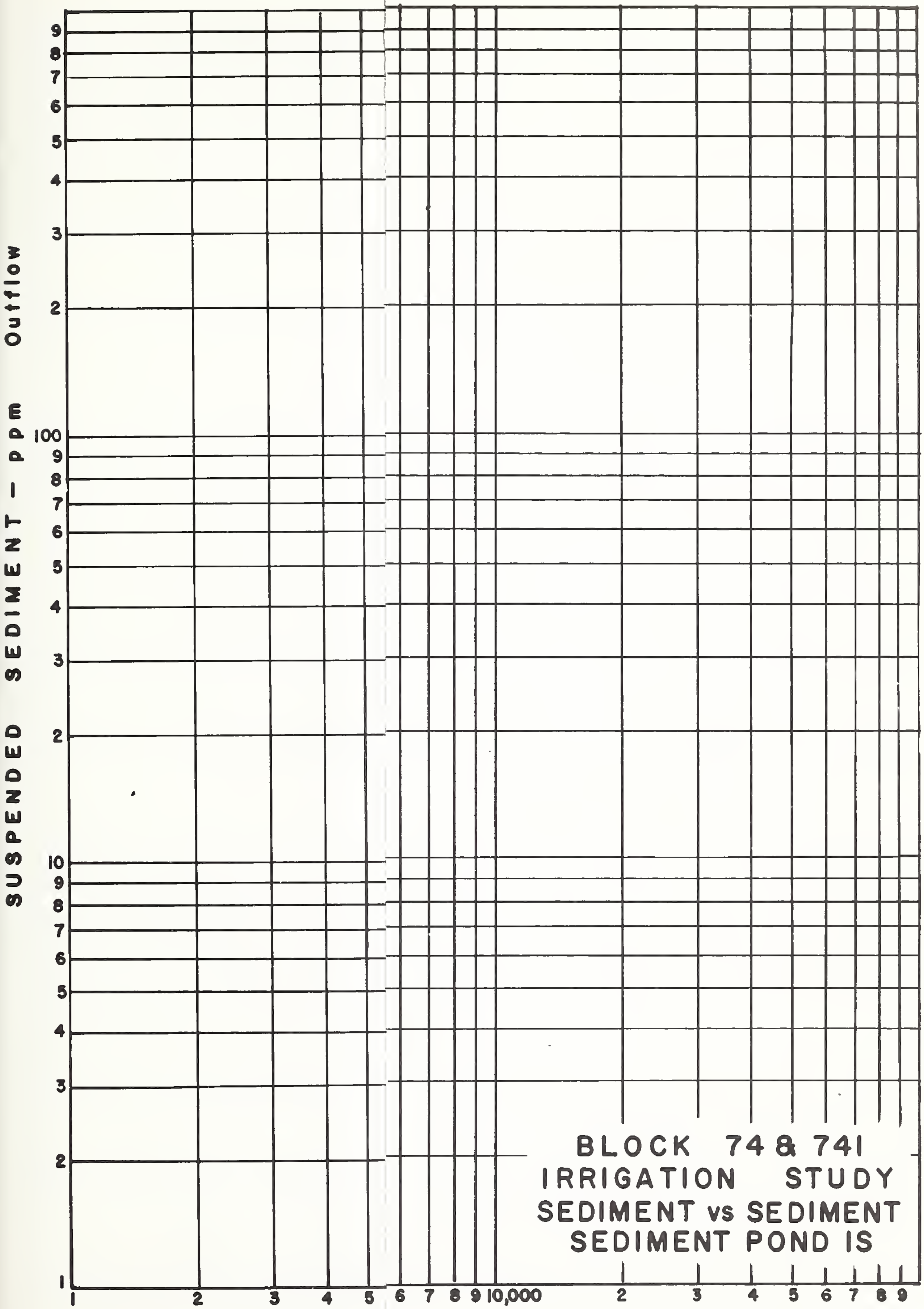
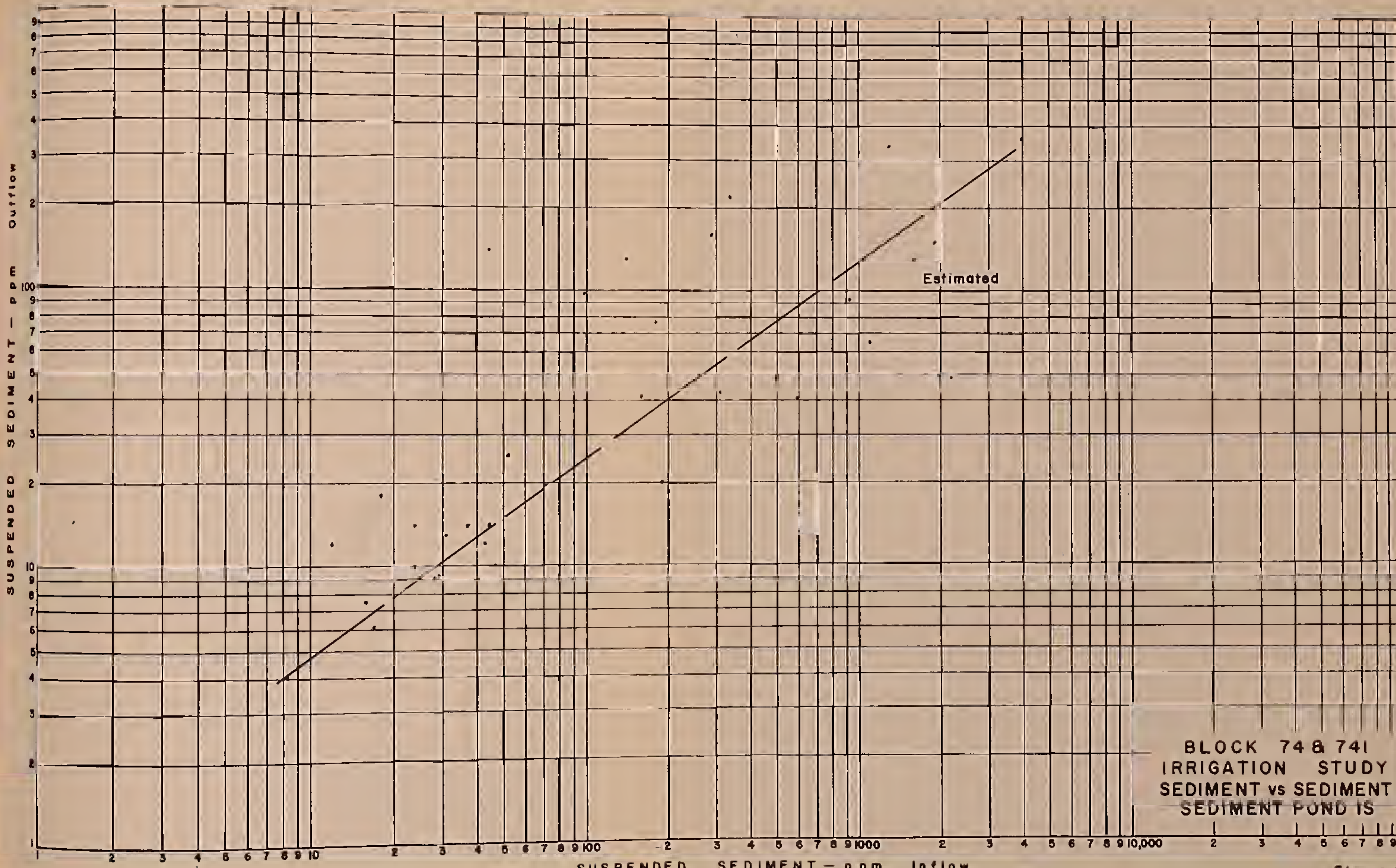
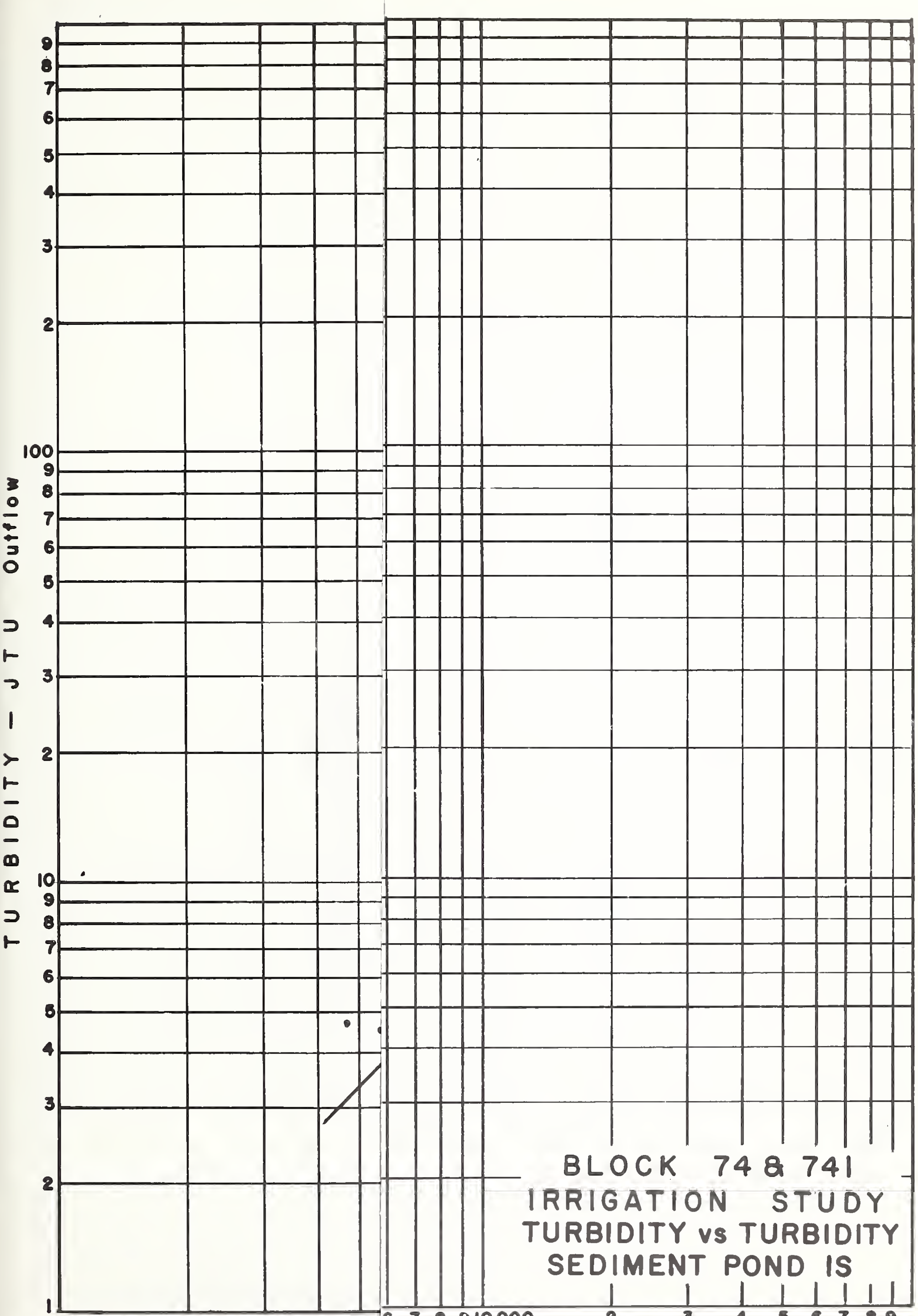

SUSPENDED SEDIMENT - ppm Outflow
100
10
1
10,000
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs SEDIMENT
SEDIMENT POND IS

Figure 24



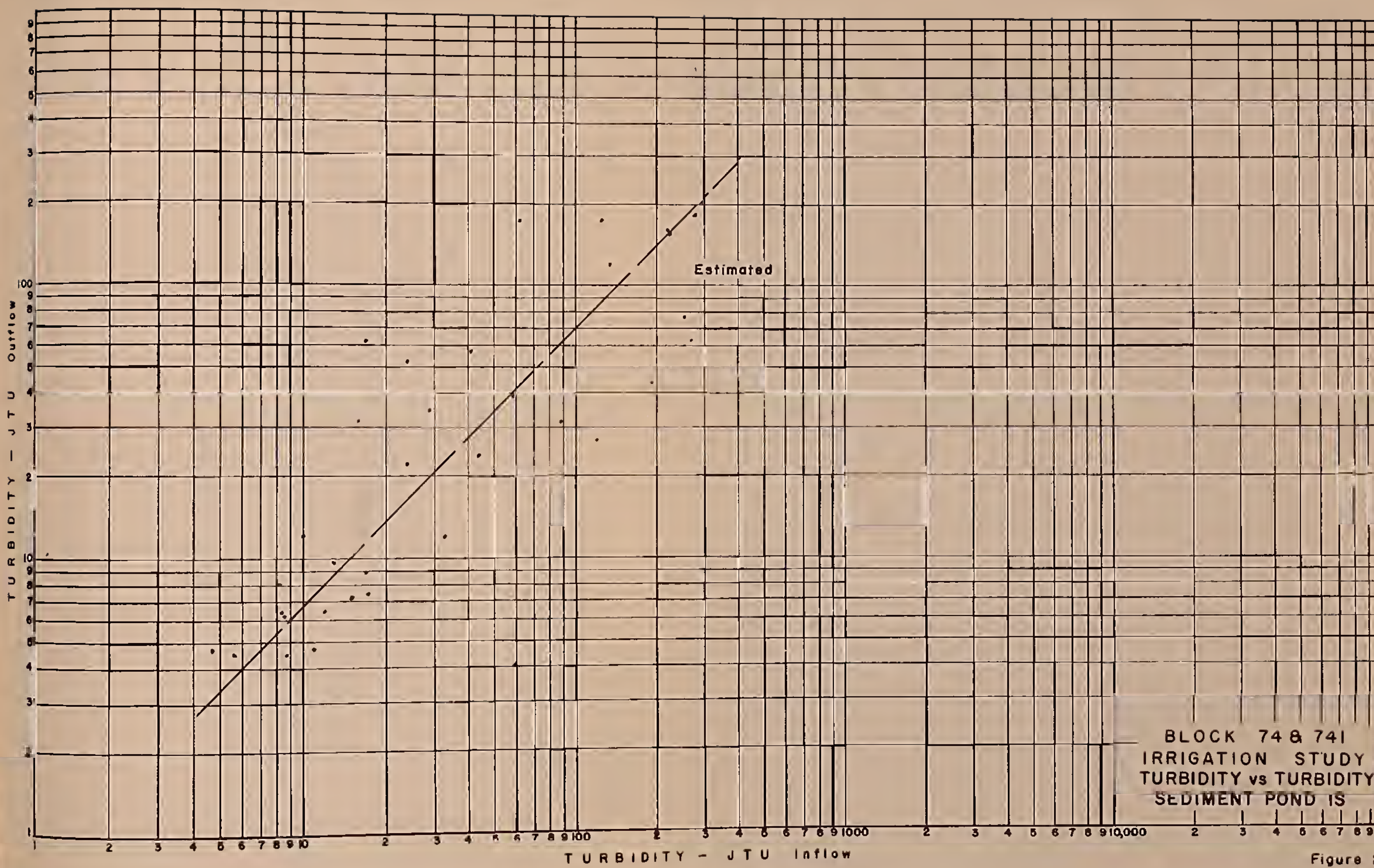
SUSPENDED SEDIMENT — ppm Outflow
SUSPENDED SEDIMENT — ppm Inflow
Estimated
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs SEDIMENT
SEDIMENT POND IS

Figure 24



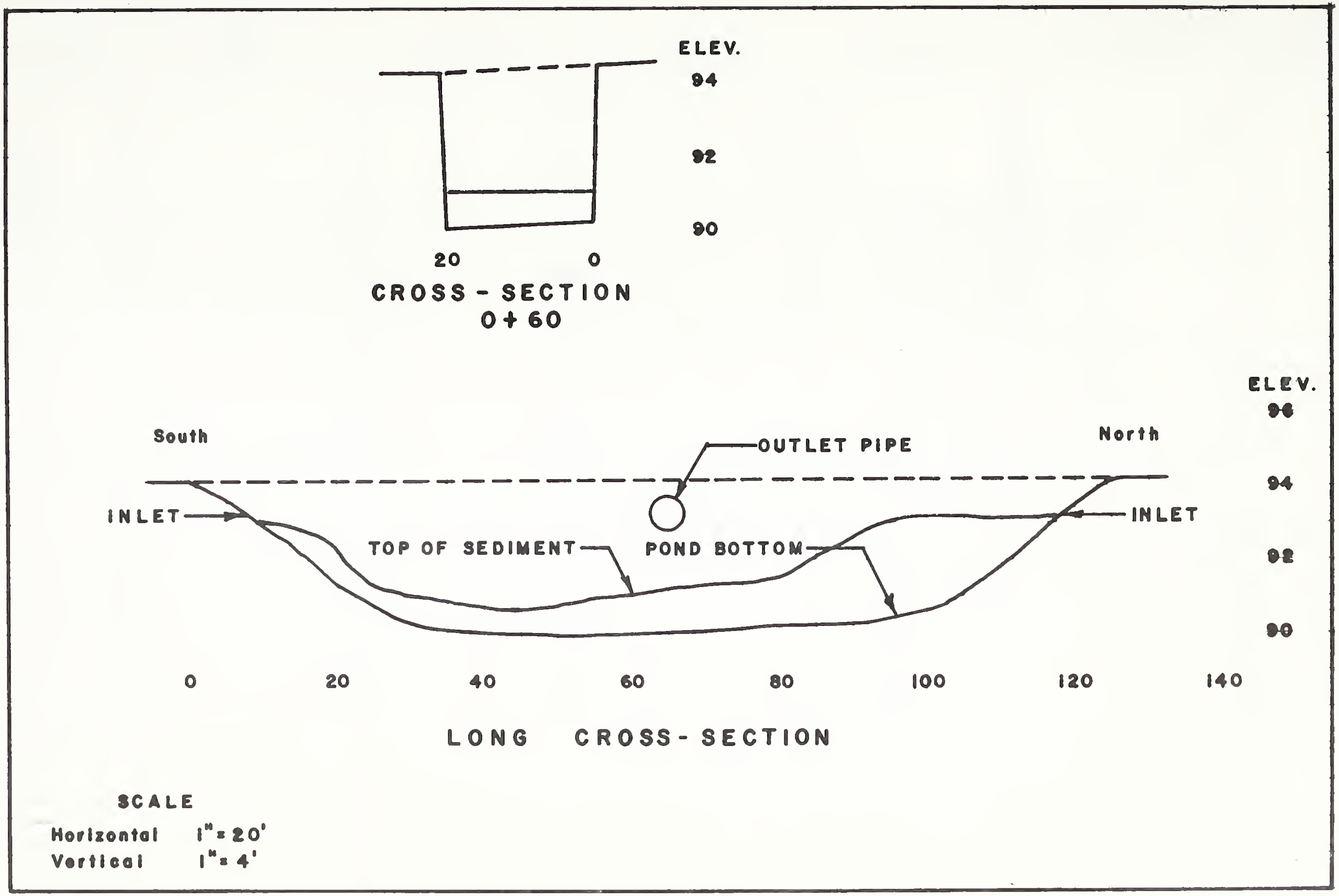
TURBIDITY — JTU Outflow
100
10
1
10,000
BLOCK 74 & 741
IRRIGATION STUDY
TURBIDITY vs TURBIDITY
SEDIMENT POND IS

Figure 25



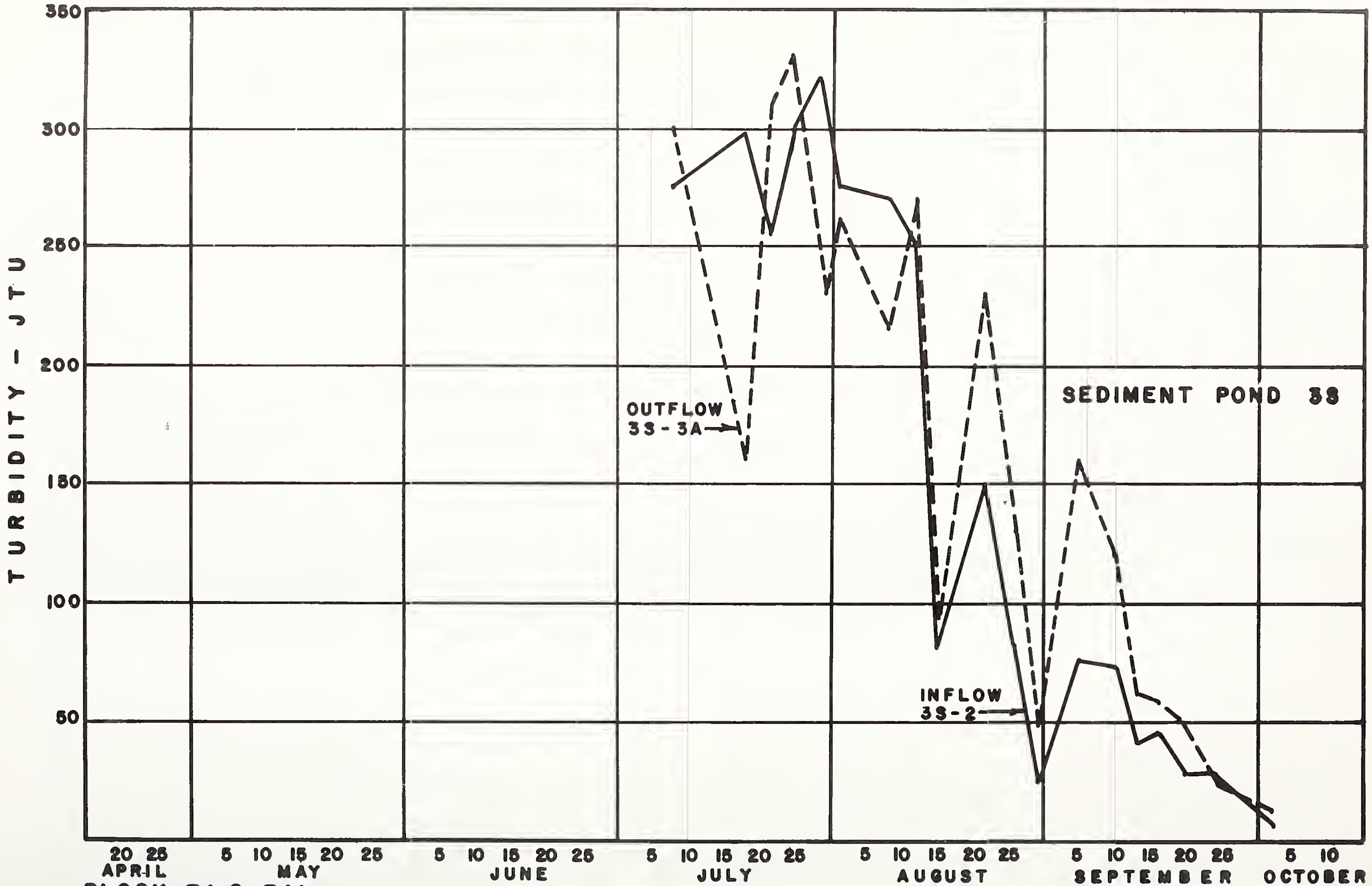
BLOCK 74 & 741
IRRIGATION STUDY
TURBIDITY vs TURBIDITY
SEDIMENT POND IS
Estimated
TURBIDITY — JTU Outflow
TURBIDITY — JTU Inflow

Figure 26



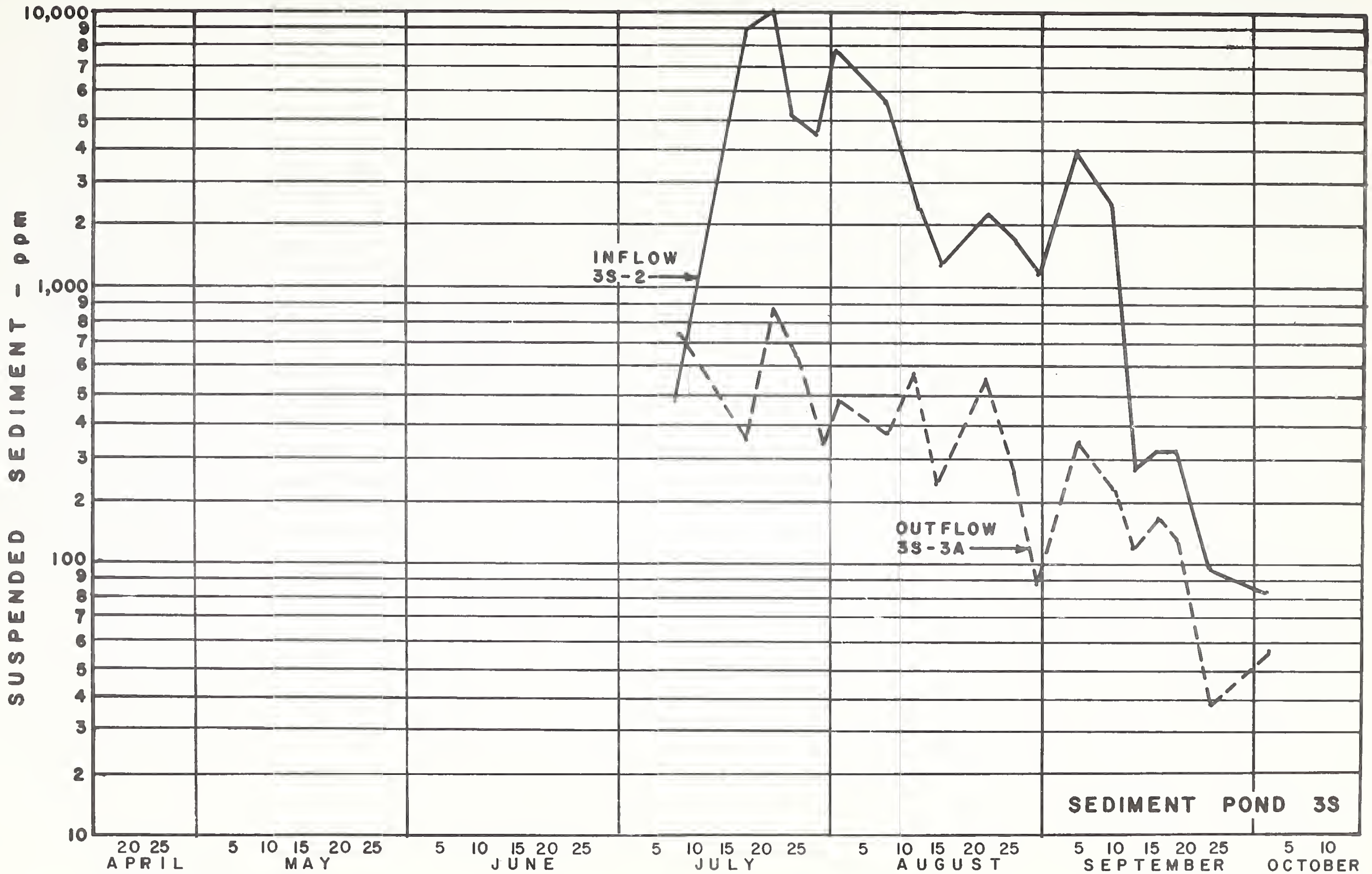
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT POND 3S
Figure 26



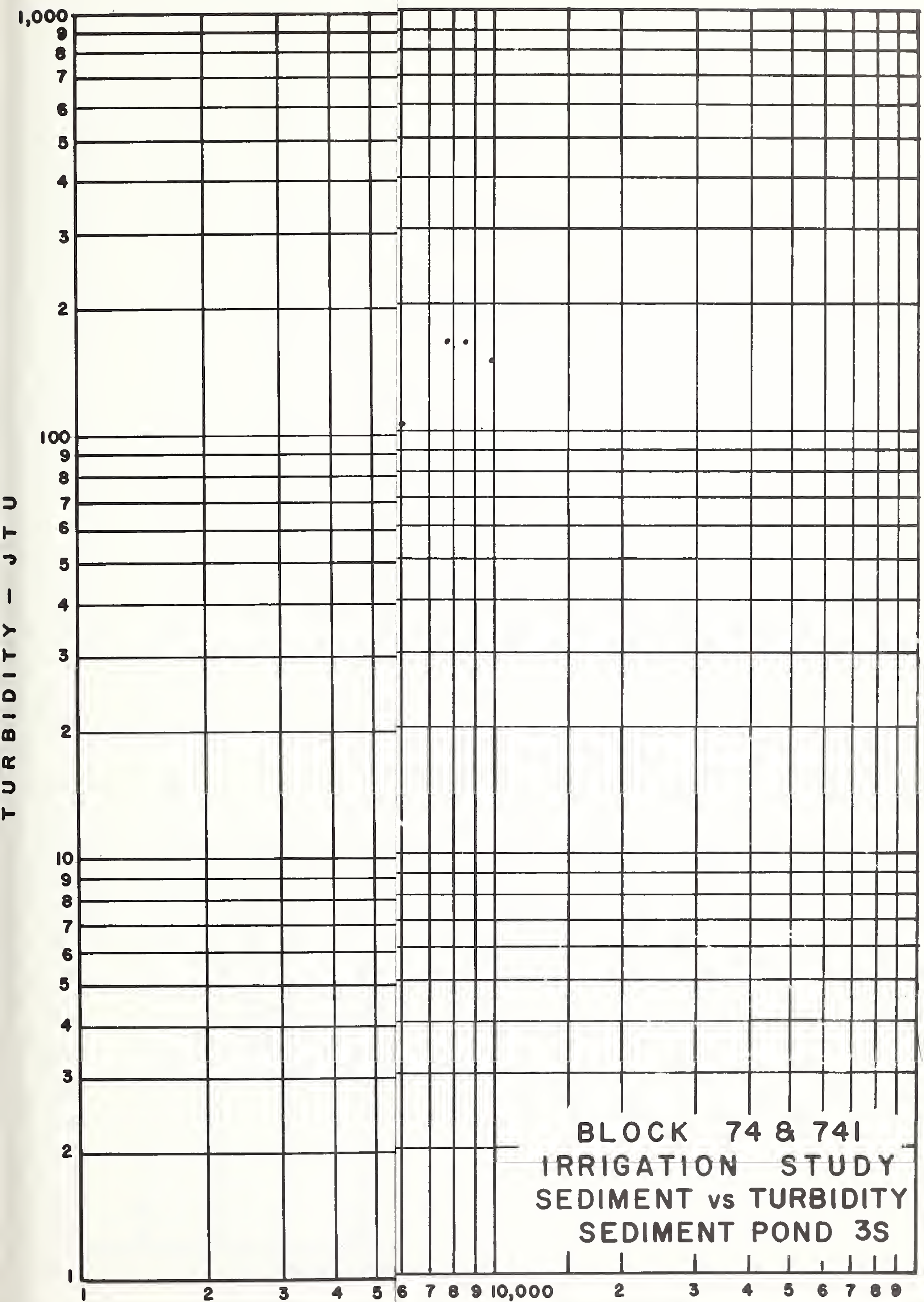
BLOCK 74 & 741
IRRIGATION STUDY

TURBIDITY vs TIME
Figure 27



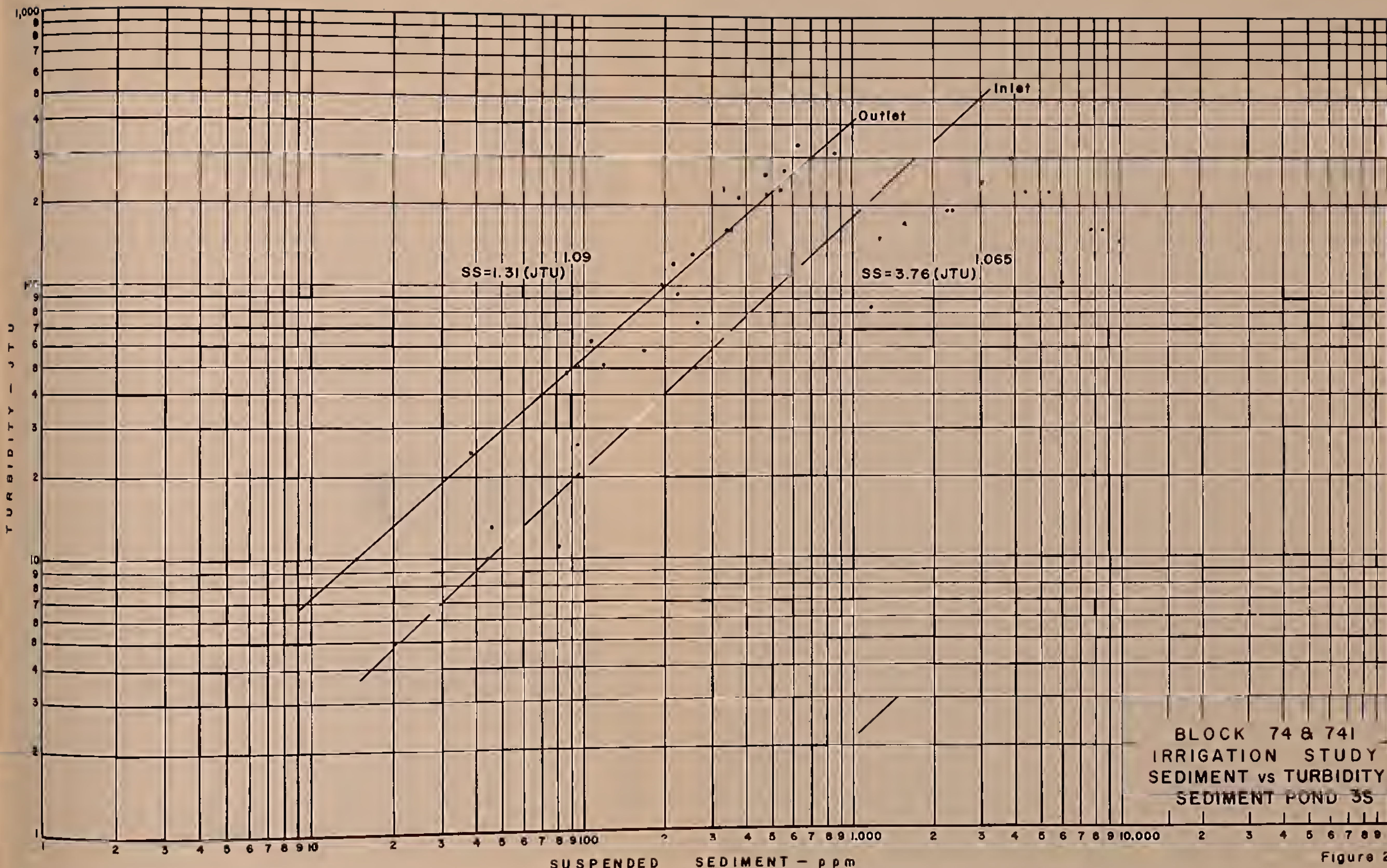
BLOCK 74 & 741
IRRIGATION STUDY

SEDIMENT vs TIME
Figure 28



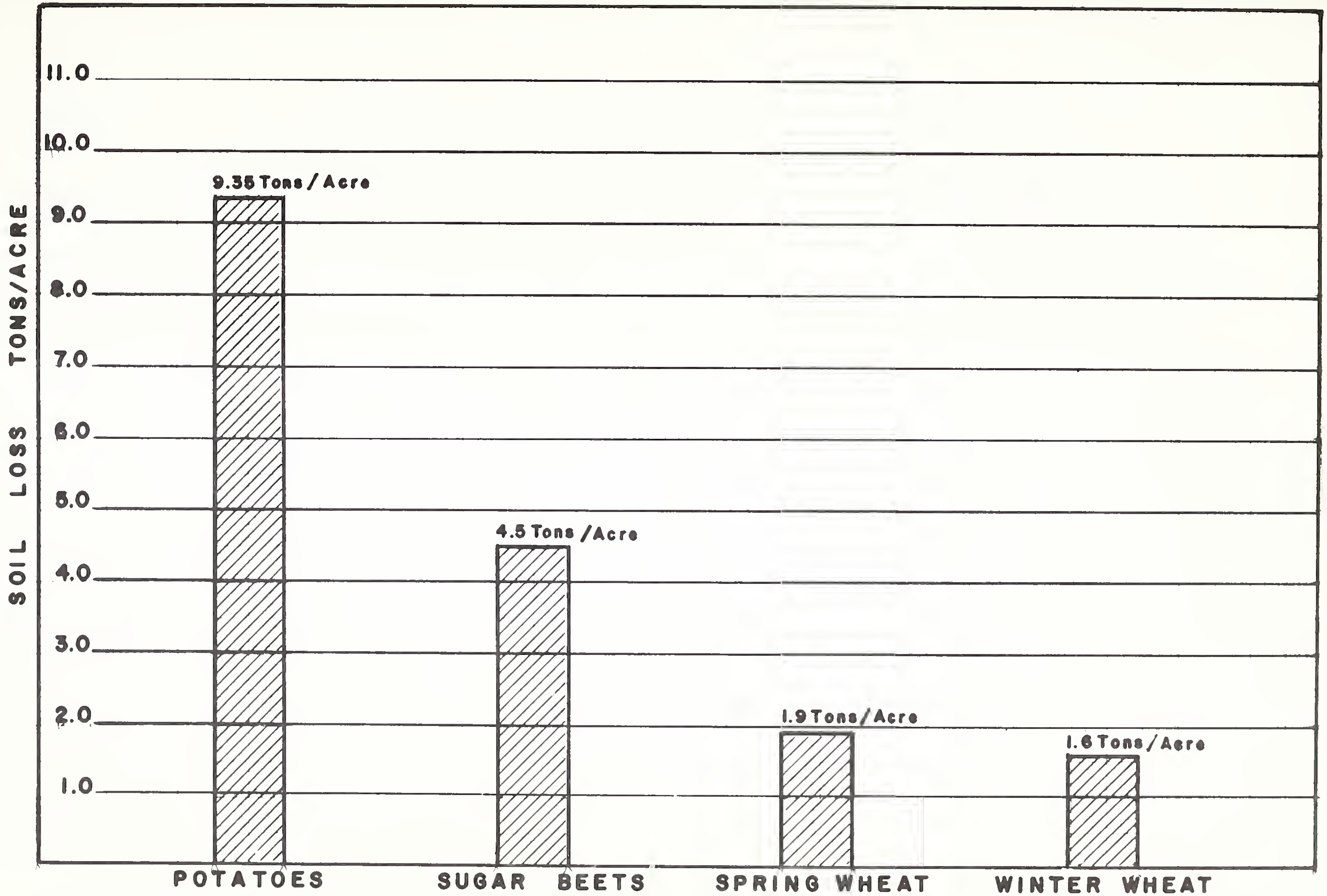
TURBIDITY — JTU
1,000
100
10
1
10,000
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs TURBIDITY
SEDIMENT POND 3S

Figure 29



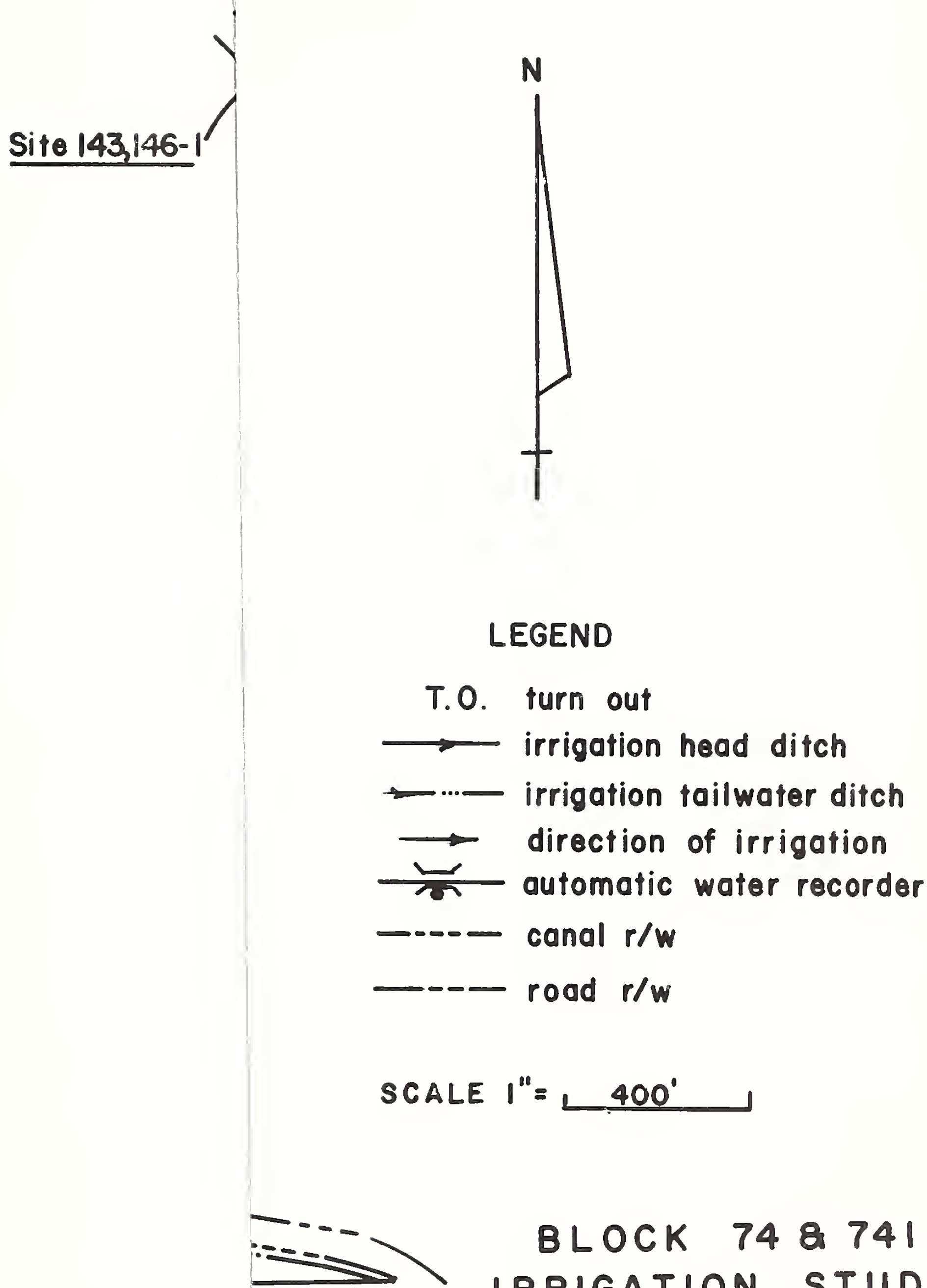
Inlet
Outlet
SS=1.31 (JTU)^1.09
SS=3.76 (JTU)^1.065
TURBIDITY — JTU
SUSPENDED SEDIMENT — ppm
BLOCK 74 & 741
IRRIGATION STUDY
SEDIMENT vs TURBIDITY
SEDIMENT POND 3S

Figure 29



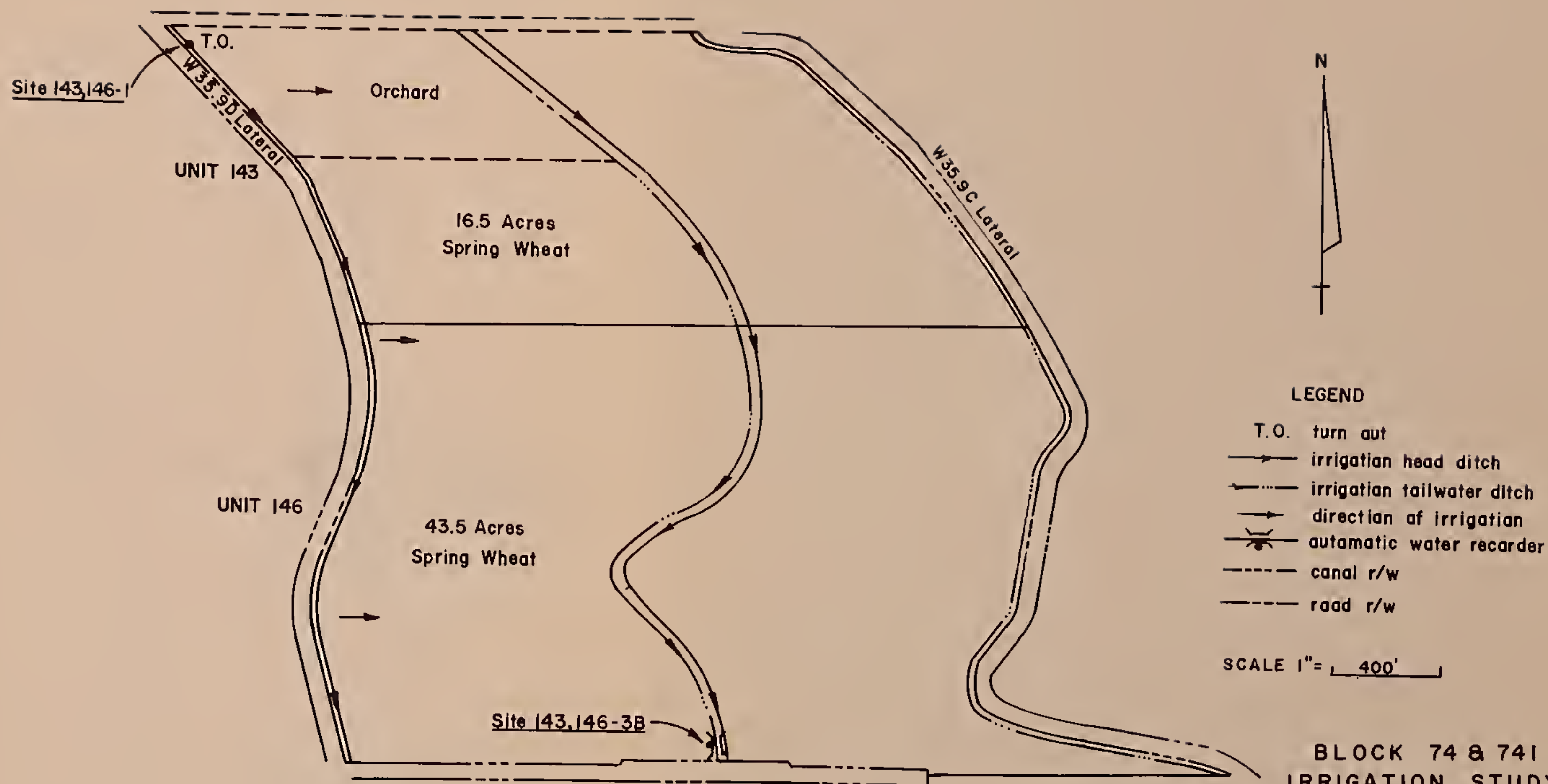
BLOCK 74 & 741
IRRIGATION STUDY

SOIL LOSS TONS/ACRE
Figure 30



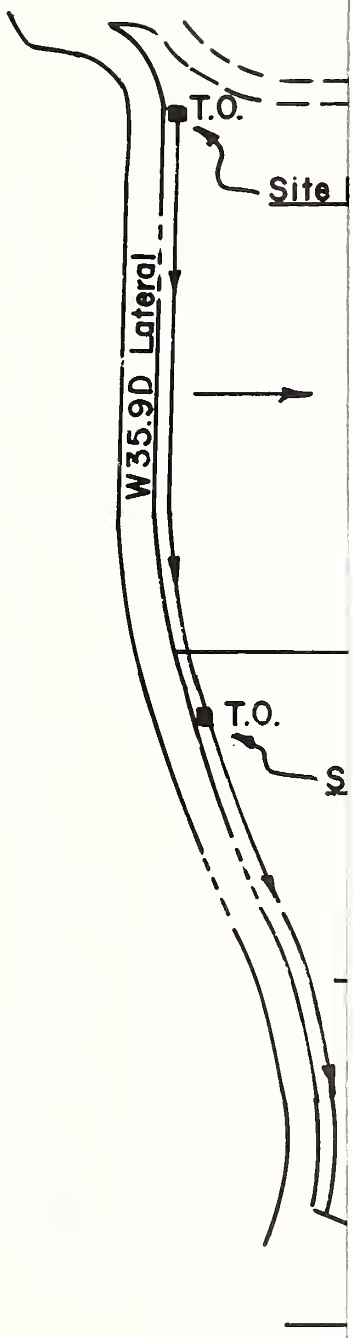
BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS

Figure 31



BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS

Figure 31

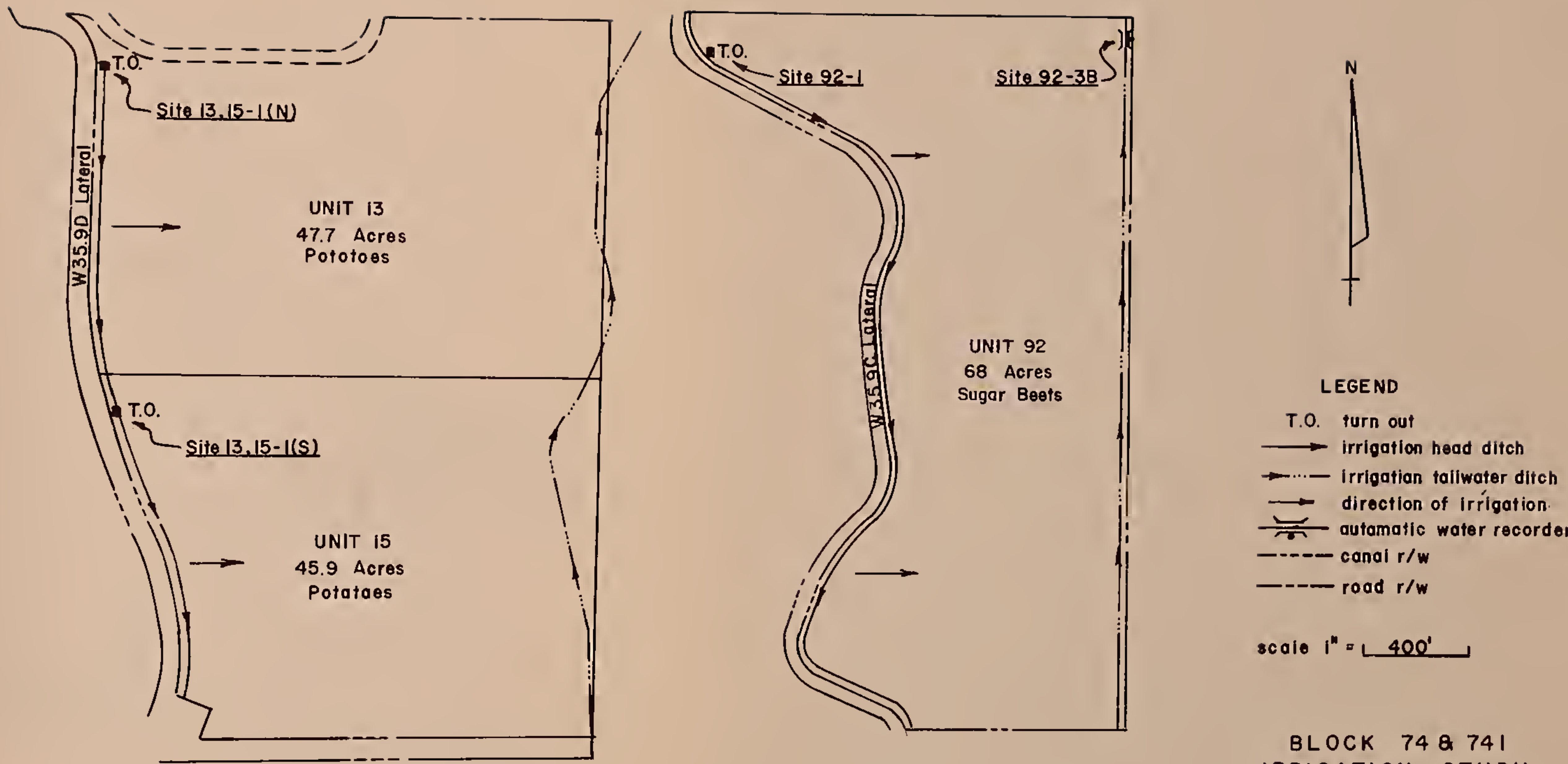


LEGEND

T.O. turn out
irrigation head ditch
irrigation tailwater ditch
direction of irrigation
automatic water recorder
canal r/w
road r/w

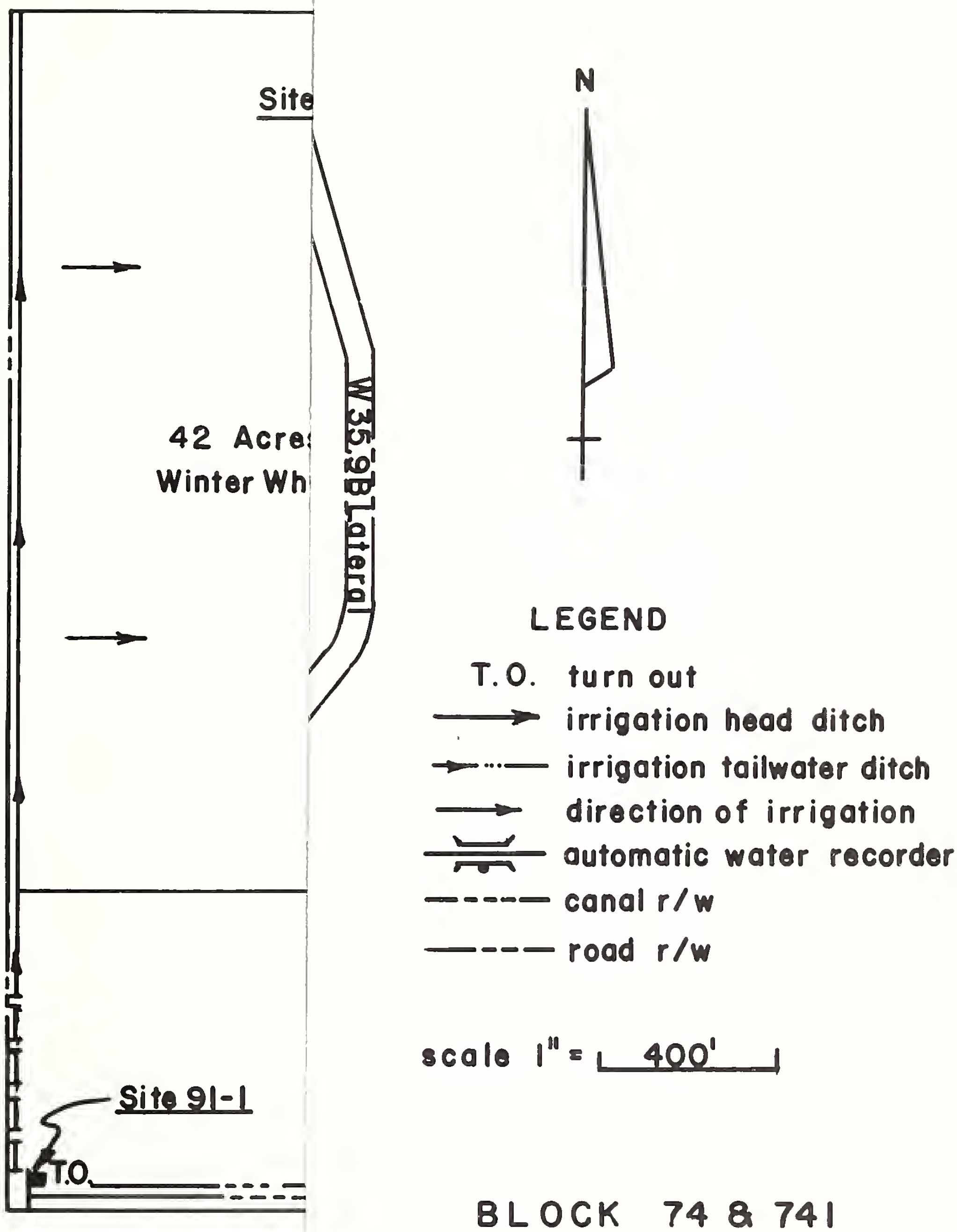
scale 1" = 400'

BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS
Figure 32

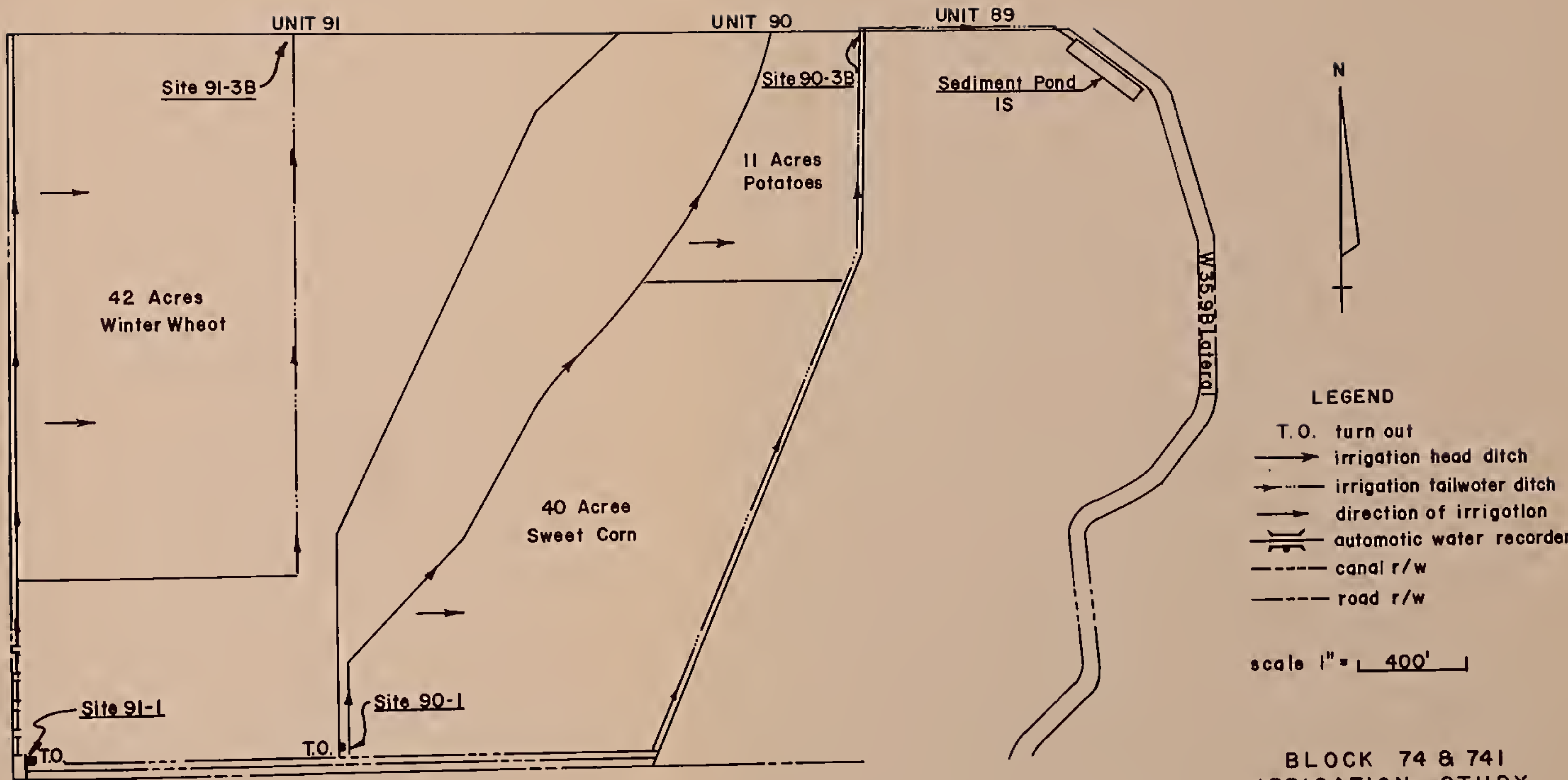


BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS

Figure 32



BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS
Figure 33



BLOCK 74 & 741
IRRIGATION STUDY
SITE PLANS

Figure 33